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ARI Research Note 88-96

# **Human Factors and Safety Assessment: M1A1 Abrams 120 mm Gun Tank, Follow On Evaluation**

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for

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November 1988



**United States Army  
Research Institute for the Behavioral and Social Sciences**

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19. Abstract (continued)

in high ambient temperature conditions, and an NBC backup system which does not filter out carbon monoxide gas (a deficiency discovered during the M1E1 operational test II in 1984).



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# HUMAN FACTORS AND SAFETY ASSESSMENT, M1A1 ABRAMS 120MM GUN TANK

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# HUMAN FACTORS AND SAFETY ASSESSMENT, M1A1 ABRAMS 120MM GUN TANK

## INTRODUCTION

### General

This report describes the Human Factors and Safety (HF&S) assessment conducted in conjunction with the Follow-on Evaluation (FOE) of the M1A1 tank. The assessment was conducted at Fort Bliss, TX, from January through June 1987. The FOE was conducted by the U.S. Army Operational Test and Evaluation Agency (USAOTEA). THE HF&S assessment support for the FOE was provided to USAOTEA by the U.S. Army Institute for the Behavioral and Social Sciences, Systems Research Laboratory, Fort Hood Field Unit.

### Purpose and Scope

The M1A1 FOE used an expanded sample data collection (SDC) methodology in a combat-unit environment (M1A1 Abrams Tank Follow On Evaluation, Test Design Plan, USAOTEA, 1986). The FOE evaluated M1A1 production models and addressed the following questions:

One, can the M1A1 tank main gun be calibrated by the average soldier using procedures prescribed in the "M1A1 Calibration Policy, FC-17-12-1A1, Tank Combat Tables"?

Two, have the materiel deficiencies disclosed during the M1E1 OT II been corrected?

Three, can the M1E1 tanks be supported with planned logistics concepts?

Four, can the M1A1 tank crews effectively use the on-board nuclear, biological, and chemical (NBC) system?

The purpose of the HF&S assessment was to provide supporting data and information to address the test issues. Much is already known about the M1A1 tank as a result of previous M1 and M1E1 tests. Therefore, the HF&S assessment priority was to support OTEA test issues, and to investigate HF&S areas where additional data are needed. The test issues that the HF&S assessment addressed included:

Calibration of the main gun. Can crews calibrate rapidly and accurately? Are there deficiencies in printed instructions? Are there problems caused by previous training and experience with other armor systems?

Deficiencies found during previous testing. Table 1 shows the HF&S findings from previous testing. The deficiencies were investigated using a combination of structured interviews, checklists, and on-site observations.

Compatibility of planned M1A1 logistic concepts with other support units. The procedures used and performance of soldiers conducting resupply support tasks were assessed by observing ARTEP task performances. Structured interviews concerning tasks and procedures were conducted.

Table 1

## Human Factors, Safety, and Health Hazards Findings as Reported in Previous M1 Testing Results

Problem	M1 OT III	Reported in:	
		M1E1 OT II	HFEA HEL
1. Lack of means for removing CO from turret if main NBC system fails. (Need outside air source for backup system.)		x	x
2. Problem removing unfired round from 120mm due to loading ramp design.		x	x
3. Tracking problem, TC's .50 MG. (Control too sensitive, hard to coordinate.)		x	x
4. No provision for human waste elimination/disposal during prolonged buttoned-up operations.		x	x
5. Inadequate storage for personal gear.	x	x	x
6. CVC helmet gives inadequate hearing protection, particularly with main NBC system <u>ON</u> .		x	
7. Variable effectiveness of microclimate cooling system.		x	x
8. No "autobahn seat" for commander for long-term open hatch travel.		x	x
9. Need improved access to "semiready" ammo rack.	x	x	
10. Difficulty using sights with masks on.	x	x	x
11. Gunner's shoulder padding (on main gun sight) too thin.	x	x	x
12. Ammo case bases separate from handling (120mm).		x	x
13. Spontaneous firing of laser rangefinder.		x	x
14. Difficulty opening/closing hull stowage compartment doors.		x	



Table 1, cont.

Problem	M1 OT III	Reported in:		HFEA HEL
		M1E1 OT II		
15. Difficult understanding speech over intercom. (Worse when NBC system <u>ON</u> .)		x		x
16. Slipping of manual breech opening handle (manual operation).				x
17. TC power handle location makes target handoff to gunner slower than required (needs to be raised).	x	x		x
18. No bypass switch to override the automatic engine (low oil pressure) shutdown.	x	x		
19. Driver's steering control adjustment pin is difficult to use and unreliable (vibrates loose).	x	x		
20. Driver's seat does not give adequate back support.	x	x		
21. Driver's vision block wipers are ineffective.	x	x		
22. Driver's side vision blocks cause distortion.	x	x		x
23. Driver's night vision viewer is marginal.	x	x		x
24. Driver's workspace is too small for most drivers.	x	x		
25. Turret must be traversed to fill front fuel tanks.	x	x		
26. Inadequate brow pad on GPS.		x		
27. Difficulty loading TC's .50 MG.	x	x		
28. Difficulty positioning and aiming loader's MG.		x		
29. Crew did not know location of NBC air valve; could be blocked, causing shutdown of system.		x		

Note. Raw data upon which this table was based were not available for the writing of this report.

Effective use of on-board NBC system. Structured interviews and on-site observations of crews performing tasks in MOPP uniforms under simulated NBC environments were conducted. Moreover, the effect of MOPP uniforms on crew calibration of the main gun and logistics support tasks were assessed during actual task performance.

### Background

M1A1 tanks were supplied to the 3rd Squadron, 3rd Armored cavalry Regiment (ACR). The squadron operated and maintained 41 of the tanks during the FOE. The USAOTEA FOE data collection effort used sample data collection (SDC) methodology during squadron new equipment training (NET), tactical gunnery training, and the Army training and Evaluation Programs (ARTEPs). ARTEP tactical exercises, conducted over a six-month period, were planned to ensure that the exercise scenarios developed data for the test issues.

### DESCRIPTION

The M1A1 Abrams tank resembles its predecessor, the M1, in most respects. The changes made in the A1 version were essentially:

Substitution of a 120mm main gun for the 105 mm used previously. (New gun is the same design used in the West German Leopard II.) This gun uses combustible-case ammunition, and required a new weapon mount and a redesigned fire control system.

Improved armor protection.

Improved suspension system, transmission and final drive.

The M1A1 tank evaluated in the FOE evolved from the M1 tank. The M1A1 Abram's upgrades include several modifications needed to defeat threat main battle tanks and other threat forces into the late 1980s and early 1990s. Figures 1, 2, and 3 show the modified features of the high performance M1A1 tank and include:

The 120mm, U.S. made smoothbore cannon using combustible cased ammunition that is compatible with that used by other NATO forces.

A refitted turret integrating a new main gun mount.

A revised fire control computer.

A redesigned suspension, gun turret drive, and transmission.

Improved armor.

A weight reduction derived from improved armor quality control techniques.

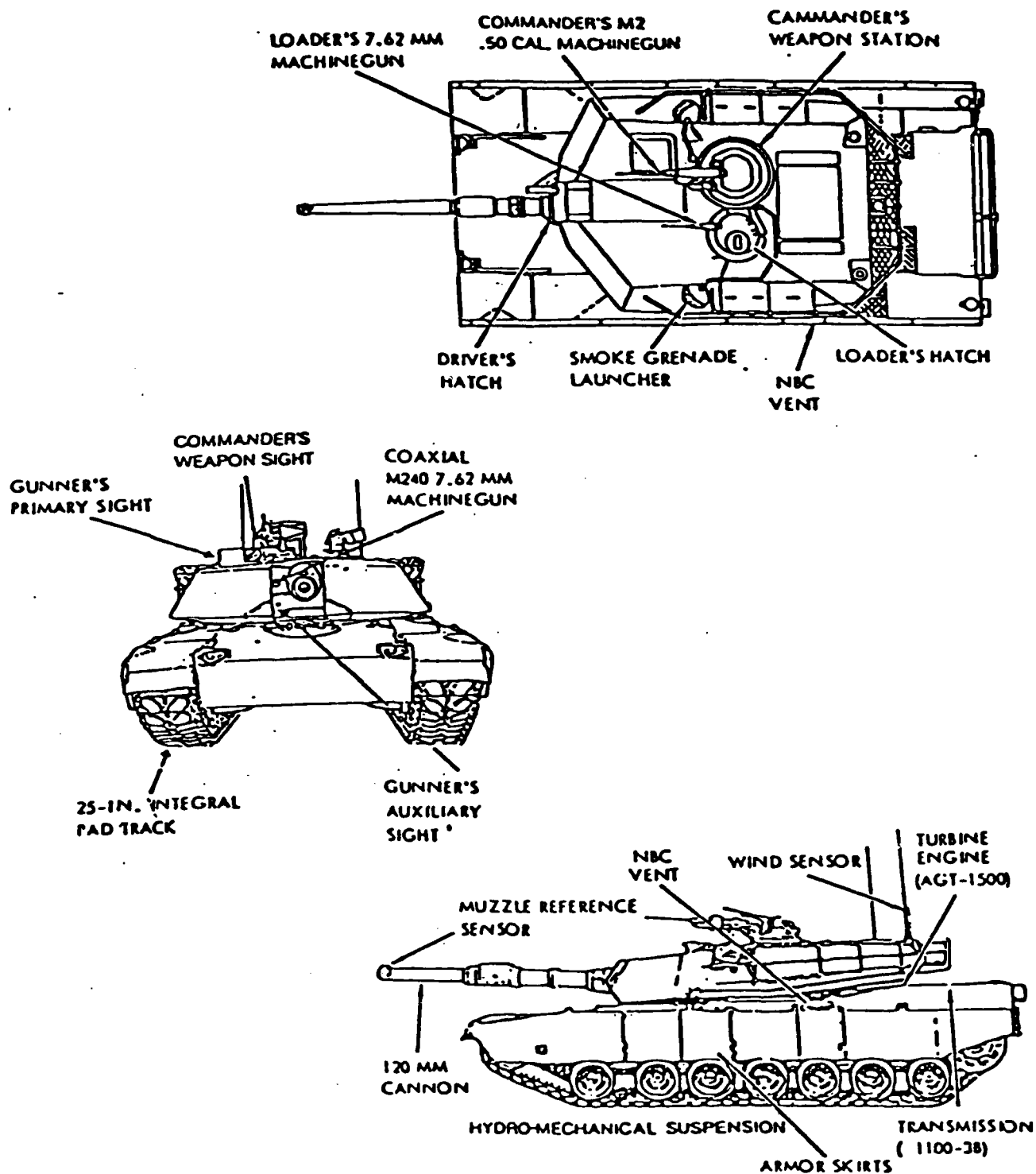


Figure 1. Improved M1A1 tank external features.

Note: Reproduced from U.S. Army Operational Test and evaluation Agency. M1A1 Abrams tank follow-on evaluation test design plan (TDP-OT-623A). Falls Church, VA, December 1986.

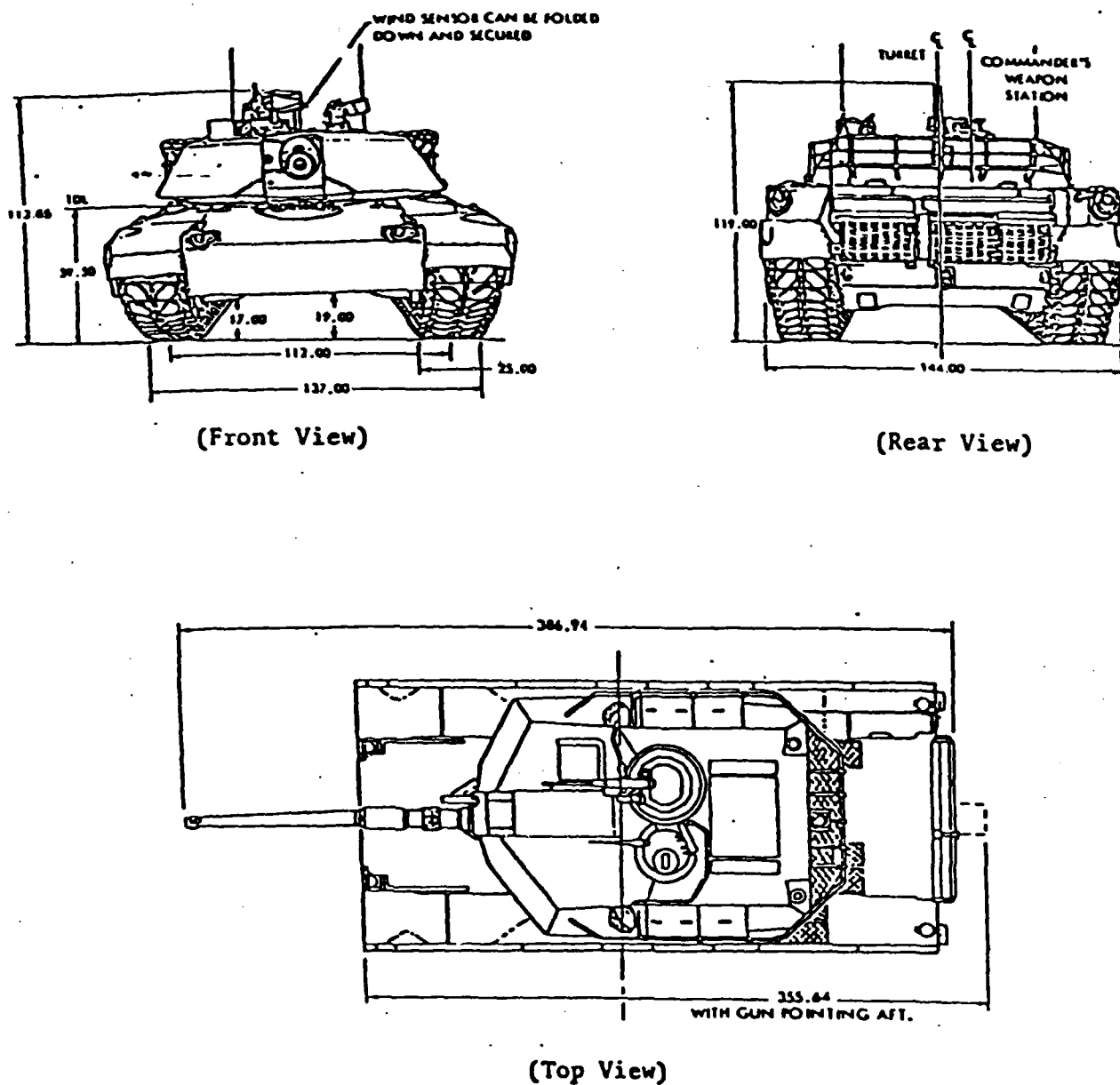
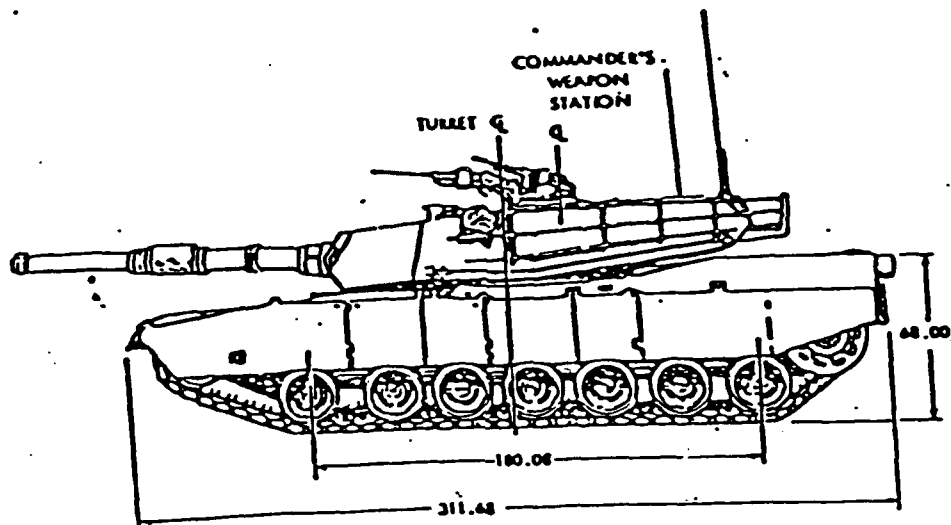
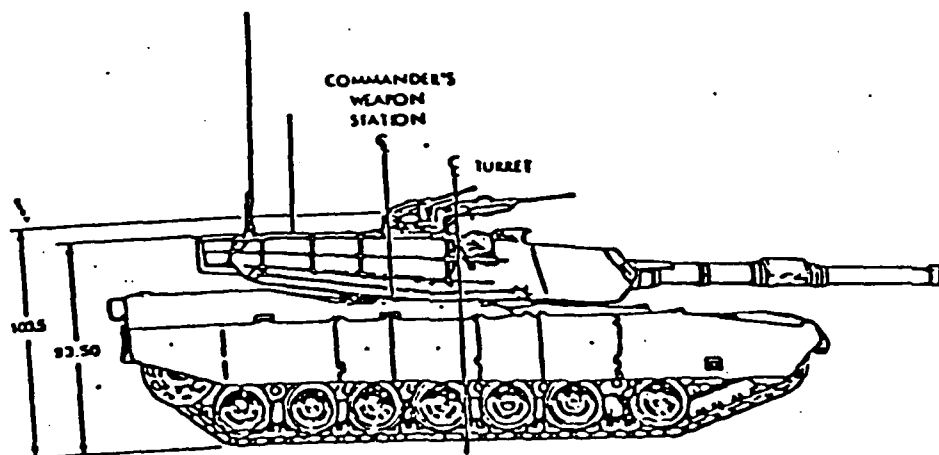


Figure 2. Improved M1A1 tank dimensional characteristics.

Note. Reproduced from U.S. Army Operational Test and Evaluation Agency. M1A1 Abrams tank follow-on evaluation test design plan 9TDP-OT-623A. Falls Church, VA, December 1986.



(Left Side)



(Right Side)

Figure 3. Improved M1A1 tank dimensional characteristics.

Note. Reproduced from U.S. Army Operational Test and Evaluation Agency. M1A1 Abrams tank follow-on evaluation test design plan 9TDP-OT-623A. Falls Church, VA, December 1986.

## METHODOLOGY

### General

FOE Test Design. The basic follow-on evaluation (FOE) was intended as an evaluation of the M1A1 as a component of a combined arms system within the receiving unit. Consequently, the OTEA test directorate decided that there would be no test artifices designed or conducted during the evaluation period. The impact of this decision, which was made prior to the involvement of the HF staff in the preparation of FOE plans (December 1986), was to preclude the conduct of instrumented side tests. The HF staff requested permission to schedule and conduct instrumented side tests to obtain performance data concerning the Rearm-Refuel-Resupply issues, but permission was not granted.

Sample data collection (SDC) was performed by a contractor under USAOTEA supervision. Data were collected during New Equipment Training (NET) in "M" company beginning in January 1987; demographic data were collected for all units at the same time. The majority of demographic data collection was completed by the end of February 1987. Initial observation of NET was completed by 15 February 1987; however, nuclear, biological, chemical (NBC) NET was conducted into June due primarily to changes in NBC operating instructions which were made by the Armor School representatives on several occasions during the FOE. Post-ARTEP crew debriefing data collection was conducted 20-24 April 1987; an additional post-ARTEP crew session was to have been conducted in May. However, lack of funds forced cancellation of the ARTEP and field exercise. Consequently, this iteration of debriefing was cancelled. Final data collection, consisting of structured interviews of test directorate personnel, contractor sample data collectors, 3rd Cavalry squadron command and staff personnel, plus the administration of end-of-test questionnaires to crews, was accomplished 23-29 June 1987.

The HF&S assessment obtained objective and subjective information to fulfill the data requirements listed in Table 2.

Table 2

M1A1 HF&S Data Collection Matrix.

OTEA	Title	Collection Information		Writing Responsibility
		Method	Source	
2.1.4.5	Crew ability to follow calibration procedures	I,Q,O S,G	C,L,S,T	Shared
2.1.4.6	Crew opinions on calibration and hitting performance	I,Q,G	C,L,S	Total
2.1.4.17	Record/report all safety related incidents	I,Q,O D,S,G	C,L,S T,M	Total

Tabel 2, cont.

OTEA	Title	Collection Method	Information Source	Writing Responsibility
2.2.6.14	Adequacy of technical manuals	I,Q,O D,S,G	C,L,T M	Total
2.2.6.21	Effects of terrain/environment of recovery operations	I,O D,S	C,L,M S	Shared
2.2.6.22	Observed difficulties in recovery operations	I,O,D S,G	C,L,M S	Total
2.2.6.23	Opinions, adequacy of M88A1 for recovery/towing M1A1	I,Q,D	C,L,M S	Total
2.2.6.26	Observed road types/conditions for transporter	I,O,D S,G	C,L,M S	Shared
2.2.6.29	Problems with HET operations	I,O,Q S,G	C,L,M S	Shared
2.2.6.30	Adequacy of maintenance organization	I,Q,O D,S,G	C,L,M S	Total
2.2.6.31	Overall maintenance problems	I,O,Q D,S,G	C,L,M S	Total
2.2.6.32	Adequacy, quantity, type usefulness of support test equipment (opinion)	I,O D,S	C,L,M T,S	Shared
2.2.6.34	Availability of support equipment (causes of nonavailability)	I,Q,O S	C,M S	Shared
2.2.6.36 a/b	STE/M1 fault isolation success/failure/causes	I,O,S S	L,M S	Shared
2.2.6.37	Observed difficulty with equipment	I,O,S	C,L,M S,T	Shared
2.2.6.38	Opinions, adequacy of test set operations, tech manuals, tool sets	I,Q,S G	L,M S,T	Shared
2.2.6.42	Type, number of vehicles <u>required</u>	I,O,S G	C,L,M S,T,U	Shared
2.2.6.45	Adequacy of resources to rearm, refuel/resupply in the field	I,Q,O S,G	C,L,S,T U	Shared

Table 2, cont.

OTEA	Title	Collection Method	Information Source	Writing Responsibility
2.2.6.46	See 2.2.6.42 (adequacy, type/ number of supply vehicles)			
2.2.6.47	Observed adequacy, type/number of supply personnel	I,O,S G	L,M,S T,U	Total
2.2.6.48	Observed adequacy of operators on hand to operate/maintain supply vehicles	O,S,G	L,M,S	Total
2.2.6.49	Observed problems chambering 120mm round due to moisture	Q,S,G	C,L,S	Total
2.2.6.50	Observed damage to 120mm round from handling	O,S,G	S,T	Total
2.2.6.51	Observed casing defects prior to loading 120mm	I,Q,S	C,S,U	Shared
2.2.6.52	Observed 120mm unpacking/ repacking problems	I,S G	L,U	Shared
2.2.6.56	Problems correcting equipment failures	I,O,D	C,M	Shared
2.2.6.57	Observed new pattern failures	I,O,S G	C,L,M S,T	Shared
2.2.6.58	Record and report all safety related incidents	See 2.1.4.17		
2.3.4.1	Observed adequacy of instructions (TM, FC, etc.) permitting the crew to operate the on-board NBC system effectively	I,Q,O S,G	C,L,S T	Shared
2.3.4.2	Observed adequacy of instructions for readability, executability, and understanding	O	T	Total
2.3.4.3	Observed availability of instructions for each tank crew and company/troop/squadron staff element	Q,O S,G	C,L,S	Total
2.3.4.4	Observed ability of crew to put the instructions to use in an NBC environment	I,O S,G	L,S,T	Shared



Table 2, cont.

OTEA	Title	Collection Method	Information Source	Writing Responsibility
2.3.4.5	Observed ability of the crew to use the NBC system properly during a no-notice NBC attack without referring to instructions	I,O S,G	L,S,T	Shared
2.3.4.6	Observed ability of the crew to properly use the backup NBC system	I,O S,G	L,S	Total
2.3.4.7	Adequacy of instructions to state conditions in which NBC system is to be used	I,Q,O S,G	C,L,S T	Shared
2.3.4.8	Observed ability of the crew to properly use the system during NBC tactical operations (firing, open hatch, closed hatch, silent watch, road march)	I,O S,G	L,S	Shared
2.3.4 (added)	Record/report any NBC system related safety incident	I,Q,O S,G	C,L,S M,U,T	Total
2.3.4a (1),(2) (3)	See paras 2.1.4.6; 2.2.6.14; 2.2.6.30 thru 2.2.6.38; and 2.3.4.1 thru 2.3.4.9, above			

Note 1. "OTEA DR" means OTEA Data Requirement.

Note 2. "Collection Method" identifies which of six collection methodologies was employed. The meaning of the six code letters is as follows:

- I = structured interview by HF staff.
- Q = questionnaire administered by HF staff.
- O = observation of field operations and examination of documentation by HF staff.
- D = debriefing of crew upon mission or task completion (post-ARTEP).
- S = sample Data Collectors observation.
- G = general narrative comment form.

Note 3. "Information Source" refers to six coded sources of information, whose meanings are as follows:

- C = tank crew performance.
- L = Unit leaders (Cmds, PLT ldrs, etc.)
- S = sample data collectors.
- T = Test directorate staff personnel.
- M = Maintenance personnel.
- U = Unit supply personnel.

Note 4. "Writing Responsibility." "Total" means that the contractor HF&S staff did all of the writing regarding a Data Requirement. When both OTEA and contractor staff contributed to the writing, the term "shared" appears.

#### Test Participants

The 3rd Squadron, 3rd ACR, fielded 41 M1A1 tanks and crews. A total of 164 crewman participated in the test. Data were obtained from personnel in the following MOSs.

- a. 19K-19Z (tank crew)
- b. 41C, 45E/K/G, 63A/E/G/H, 421A (maintainers),
- c. 76Y-76Z, 761A (supply personnel).

In addition to the above personnel, other groups that were asked to provide information included:

- a. Test Directorate personnel, including sample data collectors,
- b. Squadron personnel,
- c. "M" Company personnel,
- d. "I" Troop personnel (crews, unit leaders, and maintainers),
- e. "K" Troop personnel (crews, unit leaders, and maintainers),
- f. "L" Troop personnel (crews, unit leaders, and maintainers).

#### HF&S Team Assignments

Four different Essex contractor personnel played a role in performing the contract task to do a Human Factors and Safety assessment of the M1A1 during OTEA's Follow-on Evaluation of that system.

Management. Management functions were performed by Mr. Larry Avery from the Alexandria, VA. office of Essex.

Team Leader. The role of Team Leader was filled by Mr. Lawrence Lyons (LTC, USAR), Essex Senior Scientist from Essex's Fort Hood Facility. He performed most of the effort.

Support. Mr. William L. Warnick, Staff Scientist, assisted in the area of training assessment methodology. Dr. Albert Kubala, Senior Staff Scientist, assisted with the conduct of structured interviews. Both were from the Essex Fort Hood Facility.

#### Procedures and Materials

Permission to conduct side-tests to obtain performance data on refueling, rearming and resupply of the M1A1 was not granted. The procedures used to perform the assessment of the M1A1 FOE are described as a series of tasks in Figure 4. Appendix A contains worksheets listing the subtasks required to perform the assessment methodology. Figure 5 shows timelines for the completion of the HF&S tasks for the FOE test. Figure 6 shows specific milestones for the data collection effort. The major portion of the assessment was to support the OTEA FOE data requirements.

# REQUIRED INPUT/RESOURCE

# HUMAN FACTORS AND SAFETY TASK

# OUTPUT/PRODUCT

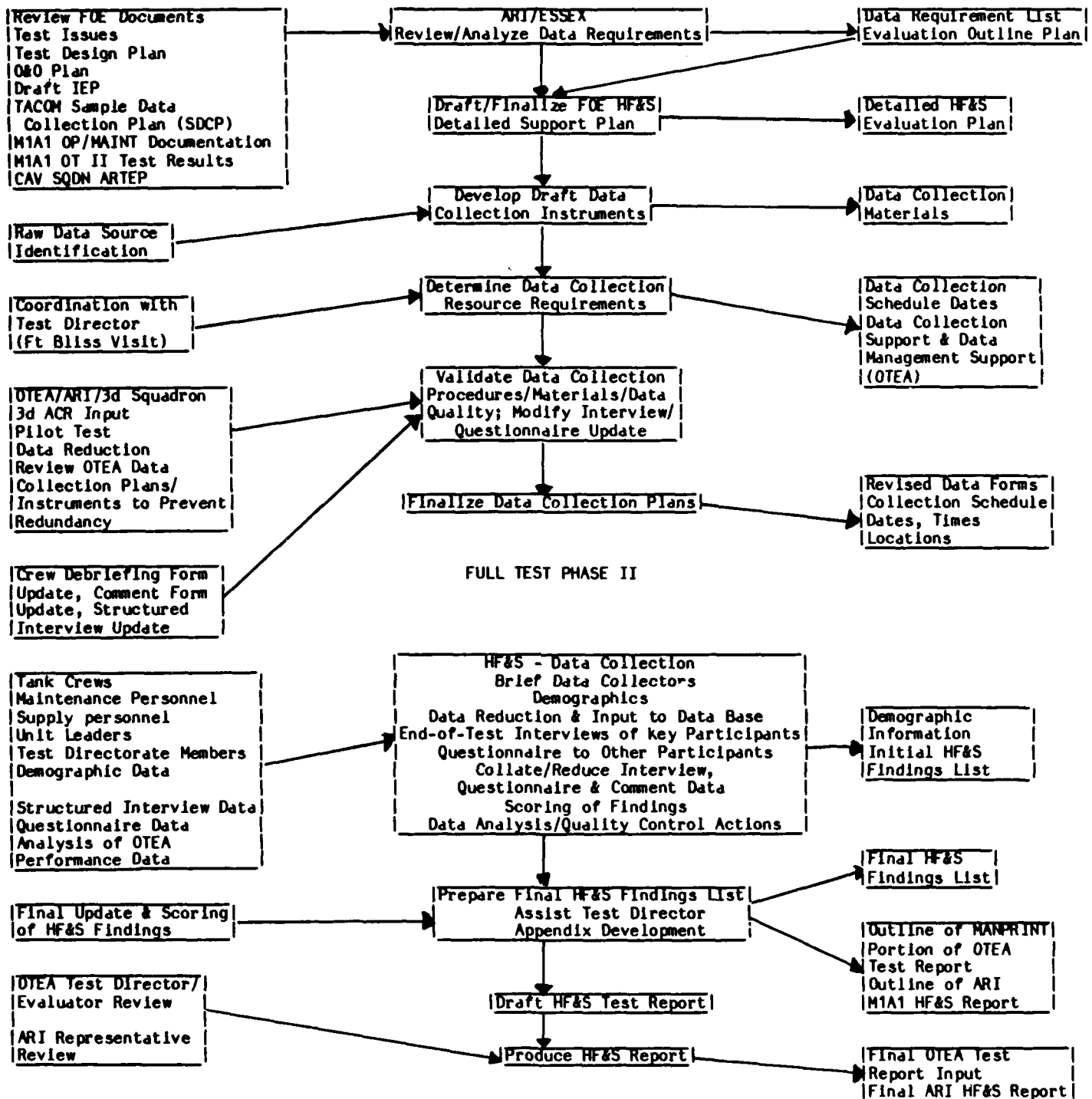


Figure 4. HF&S task identification flowchart for M1A1 FOE.

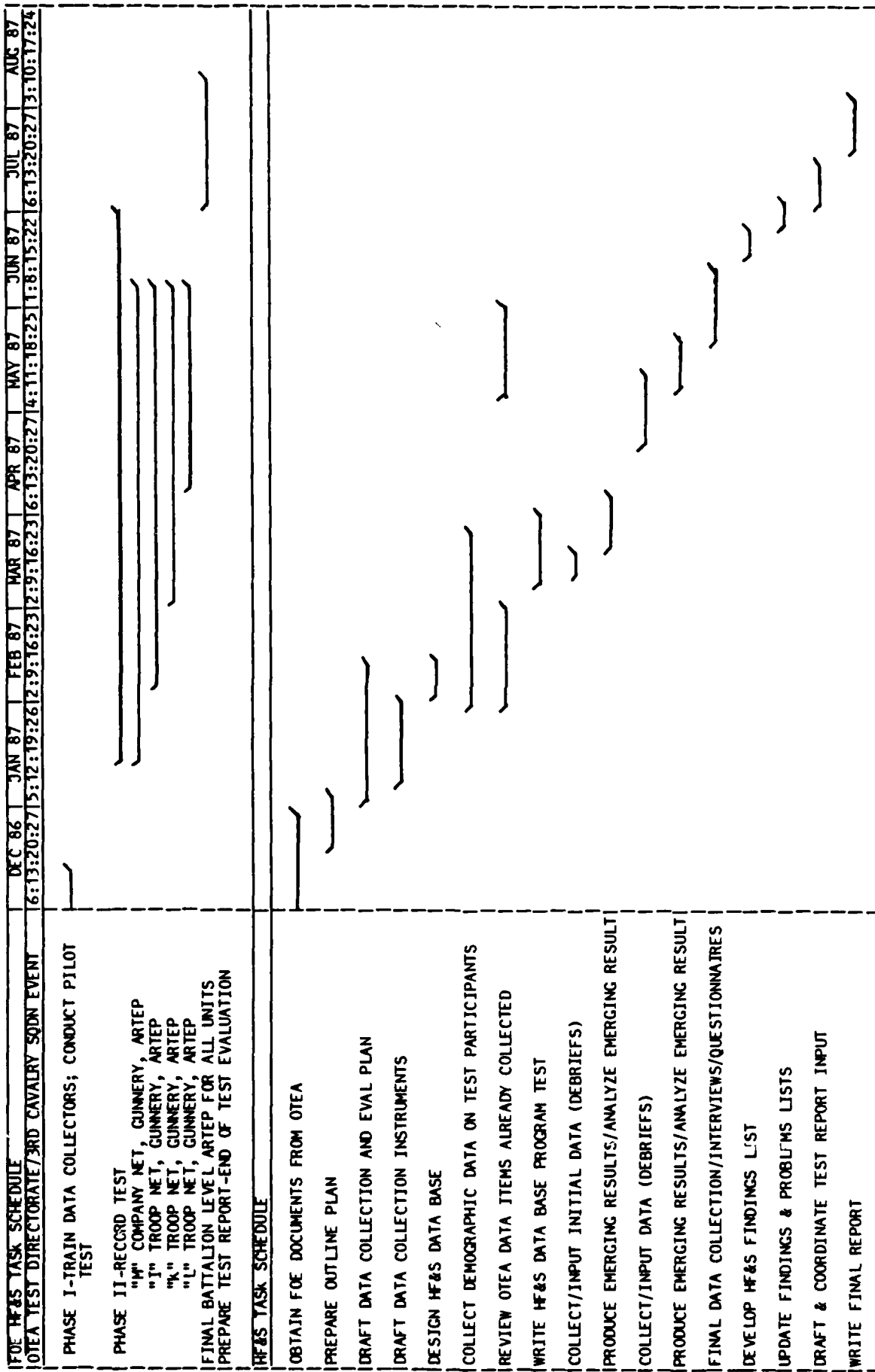


Figure 5. M1A1 HF&S follow-on evaluation milestones.

DATA COLLECTION TYPE	MONTH IN WHICH DATA IS TO BE COLLECTED					
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
DEMOGRAPHIC DATA	✓	✓		✓	✓	✓
OBSERVATION OF FIELD OPERATIONS OF UNITS		✓		✓	✓	✓
POST COMPANY LEVEL ARTEP DEBRIEFINGS				✓	✓	
POST SQUADRON LEVEL ARTEP CREW DEBRIEFINGS						✓
POSTTEST QUESTIONNAIRES						✓
POSTTEST KEY PERSONNEL INTERVIEWS						✓

Figure 6. M1A1 FOE data collection milestones.

## Structured Interviews

**General.** A major portion of the HF&S assessment was conducted using structured interviews. Interview forms are shown in Appendix C. The structured interviews were revised after the first site visit. The major change consisted of the addition of a section concerning simplified test equipment to the Maintainer interview.

**Interviews.** The structured interviews were designed to be used for obtaining data from players, test directorate and supply personnel. The structured interviews were developed as requested by USAOTEA using a Yes/No checklist format with space to record comments for each interview item. Separate interviews were conducted for each crew position, key support unit personnel, and maintainers. In some cases, a single interview item may have covered many conditions (e.g., daylight, darkness, rain, fatigues and MOPP uniforms). Each condition which affects behavior is represented in the analysis.

**Technical manual, job performance aid, and documentation assessment.** These documents were assessed using methods described in Table 3.

**Crewmen, maintainers, support and key personnel.** Structured interviews were the primary means of collecting data from crewmen, maintainers, logistics support and key personnel. Crewmen and maintainers were interviewed concerning previously identified deficiencies. Maintainers provided information concerning pattern failures, line replaceable unit (LRU) failures not meeting LRU remove and replace criteria, and parts resupply problems. Logistics support personnel and M1A1 crewmen were interviewed concerning M1A1 resupply, supply packaging, supply handling, and loading of the tank. Key personnel were interviewed concerning their observations of M1A1 operations and maintainability.

## Comment and Opinion Data Automation

A five field code taxonomy was used to identify comments received during the test. There is a field for MANPRINT primary category, MANPRINT secondary category, M1A1 equipment component, FOE test design plan issue/subissue, and critical task(s). The number of categories identified were: MANPRINT, 13; M1A1 component, 22; issue/subissue, 10; and critical task, 5. This code allows for sorting and is listed in Appendix B. All coded data were automated for storage and retrieval in format suitable for report writing purposes. (See Appendix C for HF&S data base descriptions.)

## Demographic Data Collection

Extensive demographic data were collected during the M1A1 FOE. The demographic data collection form is shown in Appendix A. Correlational analyses of individual task performance and demographic data were intended, but were not possible due to the non-acquisition of performance data.

Table 3

Potential Areas of Technical Manual Assessment, JPA, and Documentation

Potential Items	Evaluation Methods
<u>Issue 1: Firepower</u>	
Evaluation of Field Circular 17-12-1A1 "M1A1 Calibration Policy and Procedures"	Observation, interview, performance measures
Live-fire accuracy screening test or proofing to confirm calibration	Review of results of screening and gunnery
JPA assessment	Observation, documentation review, questionnaire
<u>Issue 2: Logistic Supportability</u>	
Evaluation of critical maintenance task performance	Observation, interview, data base, performance measures
Evaluation of critical tasks performed during vehicle recovery operations	Observation, interview, data base, performance measures
Evaluation of performance of maintenance and recovery tasks (to include special tools, test equipment, and technical manuals	Observation, interview, data base
Evaluation of physical environment for maintenance and recovery operations	Observation, interview
Evaluation of TMs, JPAs, other documentation	Interview, questionnaire, documentation, review
<u>Subissue 2: Special Support and Test Equipment</u>	
Evaluation of tasks performed in the use of special support and test equipment (STE/M1)	Observation, interview
Evaluation of equipment used to support the maintenance and operation of the M1A1 in an operational environment	Observation, interview

Table 3, cont.

Potential Items	Evaluation Methods
<u>Subissue 3: Conduct of Resupply of Class III, V, &amp; IX During Field Operations</u>	
Evaluation of transportation, handling perservation and packing of class III, V & IX supplies	Observation, interview
Evaluation of tasks involved in resupplying for the M1A1 tank	Observation during ARTEP interview
<u>Issue 3: NBC Doctrine and Techniques</u>	
Evaluation of crew tasks and procedures while operating in an NBC environment	Observation, interview, performance measures (OTEA SDC Data)
Evaluation of the correctness, completeness, understandability, and useability of printed instructions	Observation, interview performance measures (OTEA SDC Data)
<u>Issue - Miscellaneous</u>	
Technical manuals and related instructional materials will be evaluated on the following factors:	
a. Determining reading grade level	Computer analysis
b. Evaluate ease of use, ability to find information, format, accuracy	Interview
Additional DR coverage	
a. ARTEP task deficiencies	Interview
b. Individual & collective deficiencies	Interview
c. Performance deficiencies	Interview

Note. "Performance measures" methodology referred to above consists of selection, analysis, and correlation of pertinent data obtained in accordance with the OTEA Test Design Plan by the test directorate sample data collectors.



## Constraints

The methodology section of the original MANPRINT assessment plan discusses the procedures and materials to be used for the study. However, the methodology was impacted by several constraints that shaped the extent of the assessment procedures. The constraints include:

- a. The initial MANPRINT planning was based upon obtainable documents. Plans and procedures were modified on the basis of initial visits to the test site and instructions from the Test Director.
- b. The minimum-interference nature of the USAOTEA SDC methodology has several advantages for unbiased FOE operation of the squadron. However, the methodology did leave some variables uncontrolled.
- c. Performance measure instrumented side-tests were not conducted.

The constraints are partially compensated for by the duration of the six-month FOE. The six-month duration of the test permitted the HF&S researchers to develop a workable methodology and to collect considerable data, albeit not of a performance measure nature. The process is also facilitated by the knowledge and experience the HF&S researchers gained from the MIEI test.

## RESULTS

Data collected in accordance with the schedule and procedures described above were available for analysis on 29 June 1987. Inputs were prepared, reviewed, and submitted to USAOTEA for inclusion in the FOE final report. Results of the limited MANPRINT (warranting the more restricted term "Human Factors and Safety") assessment efforts were presented to the final meeting of the Data Analysis Group on 8 July 1987.

In conformance with USAOTEA's instructions, comment and opinion narratives were extracted from the structured interviews for use in specific tables in the main body of the OTEA FOE final report. These extracts are collected into Appendix D of this report. OTEA also requested a stand-alone appendix of the (limited) MANPRINT data for attachment to their final report. This material is included in this report as Appendix E.

Tabulations of the comments made by operators, maintainers, and other key participants are presented in appendices D and E.

## DISCUSSION AND PRIMARY CONCLUSIONS

An analysis of the data presented in Appendices D and E resulted in the following primary conclusions:

The TOE is Inadequate. It does not provide enough maintenance personnel. More experienced turret mechanics are needed. See page D-1.

There is a Maintenance Doctrine Problem. PLL is inadequate. A vehicle is needed to carry Palletized Load List (PLL), and a wheeled vehicle mechanic. All maintenance personnel stated that they did not have metric tool sets. See pages D-2 and -3.

The M88A1 Recovery Vehicle is Inadequate. It lacks the power, weight, and durability for safe and reliable recovery of M1A1 tanks. See page D-4.

Problems with Technical Manuals. They are not up to date. They aren't rugged enough for use in the field. Too many - too bulky. Should include the parts number/NSN on same page with TM illustration. See pages D-6 and -7.

Problems with STE-M1A1. Insufficient testing of NBC systems; gives false indications, more so in high temperatures; too bulky; too long to setup. See page D-8.

Problems with Rearm, Refuel, Resupply. Fuel supply was inadequate. There are enough fuelers only if all are operational; therefore need another five, one per troop/company and squadron support platoon. See page D-9.

NBC System Operation. TCs, gunners, drivers, loaders predominantly asserted that their unit's NBC SOP was effective; whereas key unit personnel and test directorate personnel (6 of 12) viewed the units as having no SOP. A warning page for insertion in TM902350-264-10-2 arrived during the FOE. It said:

#### WARNING

"Protective mask and filter unit will not protect against carbon monoxide. The mask and filter unit will only get rid of odors which would normally indicate the presence of carbon monoxide."

This deficiency in the mask and filter, discovered in 1985 testing, appears not to have been corrected. See page D-13.

#### Operations Problems

Speech over the Intercom. Intercom speech is difficult to understand, and the difficulty is increased when the NBC system is on. See page E-7.

Driver's Conditions. The driver's seat does not give adequate back support; the vision block wipers are ineffective; the side vision viewer is marginal; the night vision viewer is marginal; the workspace is too small for most drivers. See page E-7.

#### System Safety

Exhaust. The NBC system is very hot, could cause burns or start fires. See page E-11.

Turret Power. Be sure turret power is off before anyone goes on deck near the main gun. A touch of the TC's or gunner's control handle can cause the gun to "bounce". Page E-11.

Ammo Handling. All eight loaders reported dropping rounds or falling while loading, particularly while moving over rough terrain. Page E-16.

Training. Don't retrain the 19K's; concentrate on 19E's.

## REFERENCES

- Lane, N.E. (April 1986), Issue in performance measurement for military aviation with applications to air combat maneuvering (Contract DAAG29-81-D-0100, D.O. 1443). Orlando, FL: Naval Training System Center.
- U.S. Army Operational Test and Evaluation Agency. (December 1986). M1A1 Abrams tank follow-on evaluation test design plan (TDP-OT-623A). Falls Church, VA
- U.S. Department of the Army. (March 1982) The armored cavalry squadron (ARTEP No. 17-55). Washington, DC: Headquarters.
- U.S. Department of the Army. (April 1986) Tank combat tables (FC 17-12-1A1), Draft.
- U.S. Department of the Army. (April 1986) M1A1 calibrations policy (FC 17-12-1A1). Appendix), Draft.

# APPENDIX A

## TASK PERFORMANCE DESCRIPTIONS

### TASK 1

#### REVIEW AND ANALYZE DATA REQUIREMENTS

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Obtain source documents from OTEA	15 Dec 86	N/A
B. Review FOE documentation	26 Dec 86	N/A
C. Document analysis		
(1) Determine FOE test event schedule		
(2) Identify & analyze data requirements having HF&S information input requirements	31 Dec 86	N/A
(3) Develop outline of HF&S evaluation	2 Jan 87	N/A
D. Resource Requirements	<u>Source</u>	<u>Date Required</u>
(1) FOE documentation	OTEA	10 Dec 86
(2) Access to Test Director	OTEA	15 Dec 87
(3) Access to FOE Data Manager	OTEA	5 Jan 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

## TASK 2

### PREPARE HF&S DETAILED SUPPORT PLAN

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Develop HF&S data requirements	5 Jan 87	N/A
B. Develop detailed HF&S data collection plan	5 Jan 87	N/A
C. Expand outline test support plan	7 Jan 87	N/A
D. Coordinate expanded draft with OTEA and ARI	9 Jan 87	13 Jan 87
E. Revise, finalize, publish and distribute		

<u>F. Resource Requirements</u>	<u>Source</u>	<u>Date Required</u>
(1) Detailed Test Plan	OTEA	2 Jan 87
(2) Sample Data Collection Plan	OTEA	2 Jan 87
(3) Operator & Maintainer Manuals	ARI, III Corps	2 Jan 87
(4) Access to Test Director	Library System	
(5) Access to ARI Coordinator	OTEA, ARI	

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 3

DEVELOP DRAFT DATA COLLECTION INSTRUMENTS

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Review HF&S data requirements	15 Feb 87	N/A
B. Review SDC data available from OTEA data base	15 Feb 87	N/A
C. Draft HF&S data collection instruments	12 Feb 87	12 Feb 87
(1) Structured key personnel interviews		
(2) Crew questionnaires		
(3) Crew debrief forms		
(4) General comment forms		
D. Draft automated data base support requirements with OTEA data manager	2 Mar 87	2 Mar 87
E. Resource Requirements	<u>Source</u>	<u>Date Required</u>
(1) M1A1 FOE TDP	OTEA	10 Dec 86
(2) Access to SDC Data Base	OTEA	10 Feb 87
(3) Access to Data Manager	OTEA	2 Mar 87
(4) Data collection document creation & production support		

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 4

DETERMINE DATA COLLECTION RESOURCE REQUIREMENTS

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Finalize sample size limits in coordination with test director	6 Feb 87	
B. Determine data collection support available from OTEA, verify available SDC data pertinent to HF&S DRs	6 Feb 87	
C. Confirm Essex staff requirements for obtaining HF&S data	31 Mar 87	
(1) Administering questionnaires		
(2) Conducting interviews		
(3) Conducting crew debriefs		
(4) Observing field operations		
D. Compute financial support requirements	31 Mar 87	
E. Resource Requirements	<u>Source</u>	<u>Date Required</u>
(1) Access to Data Manager	OTEA	1 Feb 87
(2) Access to Test CAV SQDRN CDR/OPNS staff personnel	3/3 Armored Cavalry SQDN - OTEA	1 Feb 87
(3) Sample Data Collection Forms (SDC)	Data Management Office	1 Feb 87
(4) Sample size information from SDC effort	Data Manager	1 Feb 87
(5) Access to 3/3rd CAV Field OPNS	CDR, 3/3rd	6 Feb 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 5

VALIDATE DATA COLLECTION PROCEDURES AND MATERIALS

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Coordinate with unit for test respondent crew(s) for validation of instruments	6 Feb 87	6 Feb 87
B. Coordinate with OTEA test director for respondents for validation of instruments	6 Feb 87	6 Feb 87
C. Test, analyze draft data collection instruments	16 Mar 87	
D. Revise, update instruments	30 Mar 87	
(1) Crew debriefing form		
(2) Interview/questionnaire forms		
(3) Comment form		
E. Resource Requirements	<u>Source</u>	<u>Date Required</u>
(1) Access to 2 tank crews 2 platoon leaders; 1 platoon NCOIC	3/3rd CAV	16 Mar 87
(2) Access to FOE Test Director for directorates interviews	OTEA	16 Mar 87
(3) Access to computer and word processing support	OTEA	10 Mar 87
(4) Data collection instrument production support (for revisions)	OTEA	20 Mar 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)



TASK 6

FINALIZE DATA COLLECTION PLANS

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Review all HF&S evaluation plans, data collection instruments, and resource allocations	20 Mar 87	
B. Incorporate all required changes	20 Mar 87	
C. Provide final form HF&S evaluation support documentation to ARI and OTEA	22 Mar 87	

<u>D. Resource Requirements</u>	<u>Source</u>	<u>Date Required</u>
(1) Access to ARI Coordinator	ARI	22 Mar 87
(2) Access to OTEA Test Director	OTEA	22 Mar 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

# TASK 7

## HF&S OBSERVATIONS AND DATA COLLECTION

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Collect demographic data	30 Mar 87	
B. HF&S staff field observations	20 Jun 87	
C. SDC observations and data collection	20 Jun 87	20 Jun 87
D. Administer after-ARTEP interviews	30 Jun 87	N/A
E. Complete administration of crew debriefs	30 Jun 87	N/A
F. Draft HF&S problems list (emerging results)	20 Jun 87	

<u>G. Resource Requirements</u>	<u>Source</u>	<u>Date Required</u>
(1) Access to OTEA data base for SDC and comment data	OTEA	10 Feb-25 Jun 87
(2) Data entry support	OTEA	10 Feb-30 Jun 87
(3) Access to tank crews	3/3rd CAV SQDN	20-30 Jun 87
(4) Access to Test Directorate personnel	OTEA Test Director	20-30 Jun 87
(5) Access to DS/GS maintenance personnel	Unit Commander(s) of Personnel	20-30 Jun 87
(6) Access to LOG/Supply support personnel	Unit Commander(s)	20-30 Jun 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 8

PREPARE FINAL HF&S FINDINGS LIST

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Collate, reduce, analyze data	10 Jul 87	
(1) Interview data		
(2) Questionnaire data		
(3) Crew debriefing information		
(4) Comment data		
B. Integrate SDC observations and data	10 Jul 87	
C. Integrate gunnery performance data	10 Jul 87	
D. Integrate maintenance/log support data	10 Jul 87	
E. Analyze and integrate photo data documentation	10 Jul 87	
F. Revise, update, finalize HF&S Problems list in coordination with DAG	14 Jul 87	
G. Compute financial support requirements	31 Mar 87	

<u>E. Resource Requirements</u>	<u>Source</u>	<u>Date Required</u>
(1) Reduced SDC data	OTEA	30 Jun 87
(2) Reduced gunnery data	USATACOM	30 Jun 87
(3) Access to collected TV/ photo imagery	OTEA	30 Jun 87
(4) Access to FOE DAG	OTEA Test Director	Throughout FOE

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 9

DRAFT HF&S TEST REPORT

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Draft test report	14 Jul 87	
(1) HF&S problems		
(2) Critical task performance		
(3) Interview/questionnaire data		
B. Coordinate draft report with OTEA test director	17 Jul 87	
C. Finalize draft report and input to OTEA test report	20 Jul 87	
D. Resource Requirements	<u>Source</u>	<u>Date Required</u>
Access to Test Director, Data Manager, DAG	OTEA	30 Jun 87

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

TASK 10

FINAL HF&S TEST REPORT

<u>Subtask</u>	<u>Internal Due Date</u>	<u>External Due Date</u>
A. Coordinate final draft		25 Jul 87
(1) OTEA Test Director		
(2) OTEA Evaluator		
(3) ARI coordinator		
B. Complete final HF&S report, distribute		
(1) OTEA		
(2) ARI		
C. Resource Requirements	<u>Source</u>	<u>Date Required</u>
(1) Access to OTEA Test Director, independent evaluator, OTEA human factors personnel	OTEA	
(2) Access to ARI coordinator	ARI	

(Outside resources listed above imply coordination requirements between the HF&S staff element and the listed source.)

# APPENDIX B

## HF&S DATA REFERENCE CODE

Data Codes (5 fields)

Reference Category	HF&S Primary	HF&S Secondary	M1A1 Component
Field	1	2	3
Code: 0	Not Applicable	Same as Column 1.	A. GPS
A.	Training & Training Aids (NET)		B. Ballistic Computer
B.	Safety & Health Hazards		C. MRS
C.	Manpower		D. TIS
D.	Crew station design		E. GASRV
E.	Communications		F. Laser RNGFDR
F.			G. Main Gun
G.	Controls & Displays		H. Coax MG
H.	Anthropometric & Biomechanics		I. Main NBC system
I.	Environment		J. Backup NBC system
J.	Personnel		K. Driver's station
K.	Maintainability		L. Loader's station
L.	Logistics		M. 120mm ammo storage
M.	Other		N. 120mm ammo
N.			O. BITE/STE-M1
O.			P. Repair parts/ tools
P.			Q. Operator's instructions
Q.			R. Maintainer's printed instructions
R.			S. Maintenance Organization
S.			T. Supply organization
T.			U. Transportation assets
U.			V. Supply assets
V.			W.
W.			X.
X.			Y.
Y.			Z.
Z.			

Reference  
Category

Issue/subissue

Critical Task

Field

4.

5.

Code: 0 Not Applicable

1. Calibrate M1A1 Main Gun
2. Operate NBC Protection
3. Materiel defect
4. Refuel or rearm
5. Replace component
6. Evacuate vehicle/component
7. Previously identified
8. New problem (materiel)
9. Other

- A. Activate gunner's station  
(TM9-2350-264-19-2)
- B. Prepare GPS for boresighting  
(TM9-2350-264-10-2)
- C. Prepare ballistic computer/MRS  
(TM9-2350-264-10-2)
- D. Boresight main gun (FC17-12-1A1, APP A)
- E. Conduct live-fire screening tests
- F. Operate main NBC system  
(TM9-2350-264-10-2)
- G. Use protection mask  
(TM9-2350-264-10-2)
- H. Operate turret vent  
(TM9-2350-264-10-2)
- I. Operate NBC backup system  
(TM9-2350-264-10-2)
- J. Rearm or stow 120mm ammo
- K. Transfer 120mm ammo
- L. Pack or unpack 120mm ammo pallets
- M. Chamber 120mm rounds
- N. Isolate faults- STE-M1
- O. Remove or replace components
- P. Correct faults - repair
- Q. Drive
- R. Communicate
- S. PMCS
- T. Operate machineguns
- U. Refuel tank
- V. Handoff target to gunner (TC)
- W. Engage targets - machineguns
- X. Operate microclimate system
- Y. Acquire targets
- Z. Other

## APPENDIX C

### HF&S DATA BASE

#### General

##### HF&S Data Source Documents.

Structured interviews were conducted with crew members, unit leaders, test directorate personnel, maintenance personnel and supply personnel. These structured interviews consisted of questions covering all the HF&S test data requirements. The questions provided for "Yes-No: answers and for narrative comments. Data processing of the structured interviews forms included tallying to determine the total number of Yes-No answers for each question in a "type" interview (e.g., TC/Gunner, etc.), listing of all comments pertinent to each question, and sorting of responses into groupings based upon the five assigned HF&S Data Reference Code (HDRC) characters.

End-of-test crew questionnaires were administered to tank commanders, gunners, drivers and loaders who participated in the FOE. This questionnaire differs from the structured interview in that there is a five-point rating scale instead of Yes-No responses. It also provides for much fewer narrative comments. Data processing requirements for each type of questionnaire (e.g., TC/Gunner, etc.) include determining the total number of item. Other processing were the same as for interview data.

Comment and opinion data were collected in narrative form and assigned a HF&S Data Reference Code.

#### Specifics

Details of the inputs, processing requirements and desired outputs are attached.



## Input Data Description Interviews

<u>Element</u>	<u>Size</u>	<u>Description</u>
Q.number	32 characters, MAX	Numeric, Q.# plus the pertinent test plan para number(s) (e.g., 12). (2.2.6.47; 2.2.6.48; 2.2.6.49)
Question	Five 80 column lines per question MAX size (400 char)	Alphanumeric. Includes the complete actual question, plus the HF&S Data Reference Code and Yes__No__space (e.g., "Were there enough maintenance personnel available? Yes__No__(COK60)")
Comment	Four 80 column lines per question MAX size (320 char)	Alphanumeric. Includes space for narrative comment plus the HF&S Data Reference Code (e.g., "Not enough orgn/maint pers - need at least two more; but if drivers were trained or more maintenance, we'd have enough." (CAJ5N MDRC)

### Structured Interviews.

Data Files were set up for each category of personnel interviewed; that is the TC/Gunner, Driver, Loader, Unit Leader/Test Directorate, Maintainer, and Supply Personnel. Data Input elements are shown below with amplifying information.

<u>Data element:</u>	<u>Description</u>	<u>Field Size</u>
1. Question number	Numeric	Two 2-character
2. Question (Includes DR#, and HF&S Data Ref Code)	Alphanumeric	Five 80 column lines per MAX size Q; includes Yes/No response space.
3. Comments (Includes HF&S Data Ref Code)	Alphanumeric	Five 80 column lines per question.
4. HF&S Data Ref Code (MDRC)	Alphanumeric	Five characters
5. Total number of questions		

Structured Interview File. Data processing requirements are shown below, starting with the application of the six sorts that were performed.

<u>Sort #</u>	<u>Sort Reference Category</u>
1	HF&S Primary
2	HF&S Secondary
3	M1A1 Component
4	Test Issue/Subissue
5	Critical Task
6	Item/Question# Sequence

ADP Functions: Arrange by data code within the specified divisions.

Print out according to examples furnished in the sequence of:

Division - HF&S Primary A-K; HF&S SECONDARY A-K; M1A1  
Component A-Z; Issue/Subissue 0-9; Critical Task A-Z; Item/  
Question# Sequence (rollup)

Output Required:

1. Sort ID Name (e.g., HF&S Primary A Training, etc.)
2. Source Instrument ID (e.g., TC/Gunners; L/TD, etc.)
3. Question Number, DR ID, Question, \_\_\_Yes#, \_\_\_No#
4. Comments Made:

Example of Above:

HF&S Primary B Safety/Health Hazards

TC/Gunner

Q#16: "Have you been injured, or do you know of a person who has been injured while participating in this test? Yes 12 No 45

Comment: "The ballistic doors over the ammo storage rack slammed shut and cut my finger", etc.

Note that the same Q#16 example shown could also appear in one or more of the other sorts, if so coded.

## APPENDIX D

### ITEMS FOR M1A1 FOE FINAL REPORT

Comment/Opinion Data From HF&S Crew Debriefings that was contained in the OTEA Report Table 3-62, "Opinions on Maintenance Organization."

#### Opinions:

1. The TOE is inadequate - does not provide enough personnel. There were instances in the ARTEP when a dead tank never did get a maintainer forward to check it out.

Comment in response to "Were there enough maintenance personnel available?"

Q7, TC/Gunner Interview	Yes	16	No	17
Q9, Driver Interview	Yes	13	No	7

and "Was the squadron/troop's maintenance operation effective in terms of: Personnel authorization?"

Q8, Unit/TD Interview	Yes	10	No	13
Q3, Maintainers Interview	Yes	18	No	5

2. Both troop/company and squadron maintainers stated that more trained and experienced M1A1 turret mechanics were needed. Part of the perception that the TOE personnel authorizations are inadequate was caused by the fact that a number of the current mechanics had been trained to maintain M3 Bradleys or M113s rather than M1A1s (per squadron motor officer, squadron executive officer, and squadron commander).

These comments were made by both company/troop and squadron level maintenance personnel in response to the same set of questions as the preceding question; response was concurred in/repeated by the squadron maintenance NCOIC and motor officer.

3. Throughout the FOE, some tools were not available at all echelons. This was particularly true of metric tool sets.

Comment made by crew members in response to "Was the maintenance operation organized so that test equipment, tools, parts and qualified maintenance personnel were always available in forward areas (company trains) when needed to sustain combat operations?"

Q8, TC/Gunner Interview	Yes	15	No	18
Q10, Driver Interview	Yes	13	No	7
Q7, Loader Interview	Yes	10	No	1

and "Was the squadron/troop's maintenance operation effective in terms of: tools?"

Q10, Unit/TD Interview	Yes	8	No	15
Q5, Maintainers Interview	Yes	12	No	13

Comment/Opinion Data From HF&S Crew "Opinions on Maintenance Organization," continued.

Opinions:

1. There is a power cable (1W00f) that keeps coming loose; this cable gets cut all the time and the computer goes out; has to go to maintenance to be fixed, the crew can't fix it. It is under the left rear of the gun tube.

Statement was made by one tank crew during the first ARTEP debriefing in response to "Did the M1A1 built-in test equipment (BITE) in the control computer work correctly?"

Q9, TC/Gunner Interview                      Yes    27    No    6

The TC who made this observation described the cause and effect of this occurrence and indicated that the cable had to be replaced by DS maintenance; merely reconnecting or splicing at user lever did not work. This difficulty was mentioned later by a specific question.

2. PLL is inadequate, the parts are not on hand in the field when you need them. We need a larger PLL out in the field. This is a maintenance doctrine problem. We need a vehicle to carry PLL, also a wheeled vehicle mechanic. (About half of the maintenance personnel agreed. Half stated that current transportation assets are inadequate.)

This observation was obtained in response to the question about the maintenance operation adequacy:

Q8, TC/Gunner Interview	Yes	15	No	18
Q10, Driver Interview	Yes	13	No	7
Q7, Loader Interview	Yes	10	No	1
Q11, Unit/TD Interview	Yes	2	No	21
Q6, Maintainers Interview	Yes	17	No	6

The vehicle sufficiency comments were in response to:

Q6, Maintainers Interview                      Yes    12    No    11

3. Organization is adequate, but parts supply is not.

This comment pertains to the preceding response.

4. The maintenance data key locks up.

This comment was made by one crew member in response to the question concerning the built-in test equipment (control computer BITE).

5. All maintenance personnel stated that they did not have metric tool sets. some noted that US-sized sockets had been pounded onto metric nuts on occasion in order to effect repairs.

As noted, all maintainers stated a lack of metric tools (Q5, Maintainers Interview). Only one of these described the process of pounding sockets onto bolts, but all the other maintainers present agreed that some crews had done this.

6. There were problems getting some parts because incorrect stock numbers appeared on illustrations in the TM (or stock numbers were copied incorrectly onto requisition forms). Some parts were just not yet available in local supply due to the newness of the M1A1 at Fort Bliss.

This comment also was obtained in response to Q11 of the Unit/TD Interview and Q6, Maintainers Interview.

Several maintainers collaborated in describing problems they had encountered obtaining some replacement parts because the wrong part was ordered. There was disagreement as to the specific cause; whether the NSN was wrong in the TM parts list, or copied wrong on the requisition. No specific example was cited.

7. There were problems with STE-M1A1 (from OTEA report Table 3-68).

Even though not asked about STE-M1A1 specifically, a number of TCs indicated there had been problems with this equipment. Q9, Unit/TD Interview dealt specifically with test equipment. STE was considered a problem.

"Was the troop/squadron's maintenance operation effective in terms of: test equipment?"

Q11, Unit/TD Interview	Yes	7	No	16
Q6, Maintainers Interview	Yes	6	No	18

A supplemental interview guide was prepared after the first crew debriefings to obtain more detailed information about STE-M1A1. This was done as a result of complaints heard from crews, maintainers and Unit/TD personnel during April and May 1987.

During the interviews several maintainers stated that more work could be done by crews that was now reserved for maintenance personnel. This was in response to Q15, Maintainers Interview; about changes needed to improve maintenance effectiveness (Yes 16; No 3), however, about half of the TC/Gunners interviewed proposed letting crews do more in response to Q7, "Were there enough maintenance personnel available?" Yes 16; No 17.

Comment/Opinion Data From HF&S crew Debriefings on "Support and Test Equipment" (OTE Report Table 3-64).

Opinions:

1. Some M27 boresight devices were calibrated for 105mm, not 120mm guns.

This comment was made by two gunners in the initial post-ARTEP crew debriefing. Additional support was provided by comments made by our sample data collectors during the Unit/TD interviews in response to question numbers 2 and 3 on the TC/Gunner and Unit/TD interviews, respectively.

2. HETs were too slow, we can road march to the field in 45 minutes; HET takes 3-4 hours.

Comment made by one TC in response to Q6, TC/Gunner Interview, "Did you notice any problems when the heavy equipment transporter (HET) was used?" Yes 5; No 24.

3. There are weight problems; blew three HET tires the other day loading an M1A1 onto the truck.
4. HET tire pressure must be maintained at between 90 lbs. Any more or less pressure will produce blowouts; in other words, there is only a 6 lb tolerance. Drivers must constantly check air pressure in the tires.

(Opinions 3 & 4). Both of these comments were repeated by the NCOIC of the squadron support platoon, the squadron motor officer, and squadron maintenance NCO.

"Did you note any HET operation problems?"

Q11, Unit/TD Interview	Yes	13	No	9
Q6, Maintainers Interview	Yes	5	No	14

"Are your transportation assets satisfactory during field operations?"

Q2, Supply Personnel Interview Yes 5 No 7

5. The M88A1 is inadequate. It does not have the power, weight, or durability to be either safe or reliable for recovery of M1A1 tanks. There aren't enough M88A1s authorized to use one as a braking vehicle as required by SOP when operating in uneven terrain. When the post-ARTEP data collection was being conducted, all but one squadron-level M88A1 was deadlined due to transmission failures caused by recovering M1A1s (per squadron motor officer).

This opinion was expressed by both the squadron motor officer and the squadron maintenance NCO. All the maintenance personnel interviewed agreed. When the posttest interview of the squadron maintenance personnel was conducted, the motor officer pointed out that all but one of the M88A1s on had were deadlined due to damaged five trains (transmission and/or drive shaft) due to the extra weight of the M1A1.

6. Maintainers liked the "breakout box" tester; about half of those interviewed also liked the STE-M1A1; the rest did not. This comment was obtained in response to Q4, STE-M1A1 Supplemental Questions, "What is your preferred method of troubleshooting?" STE-M1A1 (13); Breakout Box (6).
7. Most maintainers interviewed and some tank crew members stated that the maintenance allocation chart (MAC) should be reviewed because there are some maintenance tasks now performed by unit or squadron-level personnel that crews could accomplish. This would allow some disabled vehicles to be returned to operational status more rapidly. Specific examples were not given.



Comment/Opinion Data From HF&S Crew Debriefings on "Problems on Technical Manuals" (OTEA Report, Table 3-65).

General: All responses provided for this table were obtained in a question such as "Are the task performance procedures in TM 9-2350-264-10-1,2,3 easy to read, understand and use?"

Q8, TC/Gunner Interview	Yes	22	No	11
Q10, Driver Interview	Yes	20	No	0
Q7, Loader Interview	Yes	11	No	0
Q11, Unit/TD Interview	Yes	7	No	16 (reverse wording concerning ease)

and Q14, Are there any problems with the maintenance manuals you have been furnished for the M1A1?" Yes 4 No 19

Opinions:

1. Manuals do not have all the M1A1 - specific changes.

About half the crew members interviewed stated they did not always get the new issue of M1A1-specific changes in a timely manner.

2. None of the manuals are up to date.

One driver made this statement.

3. There should be a separate manual for M1A1.

One driver made this comment; other crew members who heard this comment concurred (7 other persons).

4. The manuals are not rugged enough, should have plastic pages like other job aids.

This comment was made by four maintenance personnel who observed that they were prone to destroy the manuals while working on the tanks. Wind blows the pages loose; the pages become covered with grease, oil, etc.

5. Breechblock-firing pin repair descriptions are confusing; they illustrate an upside-down installation, causing broken firing pins. It doesn't mention opening the breech to insert the firing tester.

This problem was described in a round-about way by crew members who commented that there had been a number of main gun firing pin failures. Investigation by HF personnel discovered that the cause was incorrect installation/breechblock reassembly. The sample data collectors interviewed stated that incorrect assembly was caused by an erroneous illustration in the TM. This illustration was shown to the HF interviews.

6. Used the checklist instead; it was good.

This comment was made in response to G2, TC/Gunner Interview. Made by one TC (refers to FC 17-12-1A1).

7. The maintenance manuals:

- a. Too many.
- b. Too bulky.
- c. Foldouts are too large.
- d. Too much reference to one or more additional manuals to complete a particular maintenance task.
- e. The parts number/NSN for ordering replacement parts, along with correct nomenclature, should be printed on the same page as the TM's illustrated task performance descriptions. Troops now must look up parts data separately; this causes delays and parts requisition errors which could be avoided.

Maintainers were the only group asked about the maintenance manuals (Q14, Maintainers Interview). Items 7a-e were demonstrated to the HF interviewers by "M" Company maintainers (4 persons) in the motor pool while actually using the manuals to perform the task of replacing a recuperator in an M1A1 engine. Each observation was valid in that the reference from one manual to another, the manual size, and the need to spread out illustrations on the oily floor added significantly to the time spent trying to accomplish the task. Additionally, the pages got oil-soaked and became hard to read. The need to further refer to other charts to obtain part numbers added an additional distractor to task performance.

Comment/Opinion Data From HF&S Crew Debriefings regarding "Problems on TMDE/STE" (OTEA Report, Table 3-68).

Opinions:

1. The maintenance data key locks up.
2. STE-M1A1 has only one NBC system test. The pressure gauge needed to test the NBC system are not incorporated in any of the current equipment.

Made in response to Q4, Maintainers Interview, regarding test equipment.  
Comment made by one troop maintenance NCO.

3. STE-M1 gives false indications. Often when a "faulty" component was replaced, it again tested bad. When the actual problem was found, several parts which subsequently proved good had been replaced as having been defective. The majority of maintenance personnel stated that STE-M1A1 was accurate about 75-80% of the time. However, all mechanics in one troop (five persons) stated that their STE-M1A1 was faulty, worked correctly less than 20% of the time.

Response to Q4, Maintainers Interview. All maintainers interviewed agreed that STE-M1A1 gives false indications. The only area of disagreement about this concerned the percentage of the time that the false indications occurred. Only five persons thought the STE-M1A1 accuracy was 20% or less (as noted in the comment). All maintainers agreed that high temperatures cause STE-M1A1 to become ineffective.

4. All maintenance personnel stated that STE-M1A1 is too bulky, is difficult to transport, and takes too long for hookup and testing. One troop maintenance NCO stated that using STE-M1A1 often results in exceeding current doctrinal time allowances for operational status. This factor might necessitate a review of these time limits. Another comment was that due to size and time requirements the STE-M1A1 should not be deployed forward of squadron field trains. Due to the nature of cavalry operations, the battlefield is less linear that is the case for armor battalions which are part of a brigade or division. Consequently, cavalry squadron disabled vehicles are apt to be found at more widely scattered locations. This necessitates recovery of vehicles to a more centralized location to optimize the employment of test and repair assets.

The detailed comments concerning STE-M1A1 were in response to Q6, STE-M1A1 Supplemental Interview Questions: "What is wrong with the STE?" All agreed that STE was too bulky and hard to move to forward locations; most maintainers also indicated that hookup and testing took too long, but three or four did not agree with this comment. One maintainer observed that waiting for engine components to cool enough to test was a major contributor to increased maintenance time. While this observation is not STE-specific, it could contribute to a perception of an STE deficiency which is due to another factor.

Comment/Opinion Data From HF&S Crew Debriefings regarding "Rearm, Refuel, Resupply" (OTEAR Report, Table 3-87).

Opinions:

1. Fuel supply was inadequate. There are enough fuelers if all are operational. There should be five more fuelers, one each per troop/company and squadron support platoon. "We have to resupply personnel carrier/fighting vehicles (M3s) and self-propelled howitzers as well as M1A1s".

Comment concerning fuel resupply deficiency was in response to the question "Where forward resupply operations adequate to keep your tank supplied with fuel, rations, and ammo?"

Q10, TC/Gunner Interview	Yes	15	No	18
Q12, Driver Interview	Yes	11	No	9
Q7, Loader Interview	Yes	6	No	5

"Were the forward resupply operations able to sustain the required tempo of combat operations?"

Q12, Unit/Interview	Yes	6	No	17
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"Did your section have enough trucks to keep the unit's supplies moving forward adequately during field operations?"

Q1, Supply Personnel Interview				
Fuel	Yes	6	No	6

The squadron commander stated that there were enough fuel trucks in the TOE, provided all were operational. (Equipment readiness 100%.) Both the squadron executive officer and the support platoon leader stated that the squadron needed a 50% increase in fuel trucks, since they never had a 100% available rate of authorized vehicles.

2. The resupply capabilities are not adequate for sustained operations. The support platoon personnel who participated in the ARTEP (12 persons) all concurred that the platoon needed about 50% more personnel and transportation resources. Specifically mentioned was the problem experienced by the support platoon in refueling contaminated vehicles. There are not trained decontamination personnel in the platoon; not are there sufficient personnel of any type to perform this task as an additional duty and still refuel M1A1s in a timely manner. The problem is significantly compounded if the support platoon is at MOPP-IV.

Comment concerning inadequacy of resupply capabilities to support sustained operations was made by one person, a company commander. The comment concerning the decontamination requirement was made by the support platoon NCOIC; all members of the support platoon who were interviewed concurred with observation.

3. Ammo was a problem due to a bad lot; one instance of a reported swollen 120mm round which would not chamber.

One loader reported a swollen round which would not chamber (Q1, Loader Interview). The bad lot of ammo was brought to HF personnel's attention by the Deputy Test Director who described the problem: primer tubes blowing off of the brass case heads when the round was fired.

Comment/Opinion Data From HF&S Crew Debriefings regarding "Supply Vehicle Operation and Maintenance" (OTEA Report, Table 3-90).

Opinions:

1. A lot of the time HMMTs are deadlined. A truck maintenance problem.

This comment was made by the Support Platoon leader (one person). (Q2, Supply Personnel Interview).

2. Supply vehicles can't keep up with the M1A1s; they move too fast. Sometimes tanks would operate for 10-12 hours before they could be refuelled.

This observation was made by the Support Platoon leader (one person). (Q2, Supply Personnel Interview).

Comment/Opinion Data From HF&S Crew Debriefings regarding "120mm Ammunition Problems" (OTEA Report, Table 3-92).

General: All these comments, except for 4 below, were made by loaders in response to questions 1-3, Loader Debriefing.

Opinions:

1. One round seemed a little oversized but it chambered.

Made by one loader.

2. Stick with combustible ammo.

Suggested by one loader; the rest of the loaders interviewed agreed that the caseless ammo was better than the type used before (105mm metallic).

3. One swollen round of 120mm ammo was reported which could not be chambered. No one interviewed was certain of the cause.

Reported by one loader.

4. Ammunition with scratches or nicks was classified unserviceable when it was not actually cracked through the case. A clear understanding of actual unserviceability must be gained by ordnance personnel, supply personnel and tank crews.

Comments expressed by the Squadron Commander and Executive Officer during interview in response to Q14 of the Key Unit/TD Personnel Interview.

Comment/Opinion Data From HF&S Crew Debriefings on NBC (OTEA Report, Table 3-93).

Opinions:

1. Filters clog up too much, then it doesn't work. The backup NBC system in our tank didn't work at all.

Comment made by one tank commander in response to Q12, TC/Gunner Interview, "Were you able to operate the NBC system by using the instructions in TM9-2350-264-10-1, 2 & 3?" Yes 33; No 0. This problem may have been limited to one vehicle. No other comments of this specific nature were obtained.

2. Our unit NBC SOP needs to be revised to conform to the M1A1 capabilities and characteristics.

Made by one company commander in regard to his unit's NBC SOP, in response to Q13, TC/gunner Interview, "Was your unit's NBC SOP effective?" Yes 26; No 3. Note that while drivers answered Yes 11; No 4; to the same question, loader response (Q11, Loader Interview) was somewhat different: Yes 18; No 0; Don't know, 3. Additionally, Key Unit/TD personnel responded to Q16, "Did any crews have problems complying with unit SOP regarding NBC system employment?" as follows: Yes 6; No 6; "Had no SOP"; 11.

3. About 60% of all crews did not use the NBC system during the FOE (2 Test Directorate personnel).

Opinion expressed by two Test Directorate NCOs in response to Q15 and Q16, Key Unit/TD Interview.

4. They only taught us how to turn it off and on, not how it works or how to troubleshoot the NBC system when it quits. (Comment made by a number of tank crew members and several maintainers. Supported by Test Directorate sample data collectors interviewed.)

Comment made in response to NBC system questions cited above.

5. Although there were no reported injuries caused by the M1A1 or any associated equipment during the FOE the following warning appears on page 2-373, change 4, TM902350-264-10-2, received while the FOE was in progress:

WARNING

"Protective mask and filter unit will not protect against carbon monoxide. The mask and filter unit will only get rid of odors which would normally indicate the presence of carbon monoxide."

This carbon monoxide poisoning hazard was one of the serious deficiencies identified during the M1E1 OT II conducted in 1985. It appears that this deficiency has not been corrected.

Observation made by Test Directorate HF personnel at the time of receipt of Change 4, TM 9-2350-264-10-2 at the Fort Bliss Field Office, USAOTEA.



## APPENDIX E

### HF&S FINDINGS TO USAOTEA FOE FINAL REPORT

This section would have been entitled MANPRINT if a full and complete MANPRINT evaluation of the M1A1 had been conducted as a part of the FOE. Specifically, no attempt was made to do a thorough study of (a) the personnel strength authorizations contained in TOE 17-55J, or (b) the appropriateness of the task performance capabilities of the MOSSs available within the test squadron. Additionally, the New Equipment Training (NET) sufficiency question was addressed only subjectively by way of opinions obtained in tank crew debriefings, key personnel interviews, and questionnaires.

Table E-1 contains a list of test report data requirements which were either assigned to the FOE staff HF&S representative for investigation by the OTEA Test Director, or for which the HF&S representative assumed an investigative responsibility without being specifically tasked to do so.

HF&S data obtained has been entered in a separate data base. This data is arranged according to pertinent test report data requirement paragraph numbers and can be accessed in a number of ways, e.g., DR para no., or by "HF&S Data Reference Code" number. (See Table E-3.) Table E-4 shows the numbers of persons from whom data have been obtained.

The preponderance of investigation in MANPRINT areas during the FOE was focused upon the man-machine interface, health hazard and safety issues; the HF&S data collection effort produced information applicable to test issues addressed in the body of the report as well as those which appear nowhere in the report outside of this appendix. Specifically, information was solicited about previously identified deficiencies of the M1A1 which were not encompassed within the OTEA definition of materiel pattern failures (see Tables E-2 and E-7).

Tables E-5 through E-8 contain comments/opinions obtained during crew debriefings which did not specifically pertain to tables in the body of the report.

Table E-1

## M1A1 HF&amp;S Data Collection Matrix

DR Para	Title	Method	Source Group	Writing Responsibility
2.1.4.5	Crew ability to follow calibration procedures	I,Q,O S,G	C,L,S,T	Shared
2.1.4.6	Crew opinions on calibration and hitting performance	I,Q,G	C,L,S	Total
2.1.4.17	Record/report all safety related incidents	I,Q,O D,S,G	C,L,S M	Total
2.2.6.14	Adequacy of technical manuals	I,Q,O D,S,G	C,L,T T,M	Total
2.2.6.21	Effects of terrain/environment of recovery operations	I,O D,S	C,L,M S	Shared
2.2.6.22	Observed difficulties in recovery operations	I,O,D S,G	C,L,M S	Total
2.2.6.23	Opinions, adequacy of M88A1 for recovery/towing M1A1	I,Q,D	C,L,M S	Total
2.2.6.26	Observed road types/conditions for transporter	I,O,D S,G	C,L,M S	Shared
2.2.6.29	Problems with HET operations	I,O,Q S,G	C,L,M S	Shared
2.2.6.30	Adequacy of maintenance organization	I,O,Q D,S,G	C,L,M S	Total
2.2.6.31	Overall maintenance problems	I,O,Q D,S,G	C,L,M S	Total
2.2.6.32	Adequacy, quantity, type usefulness of support test equipment (opinion)	I,O D,S	C,L,M T,S	Shared
2.2.6.34	Availability of support equipment (causes of non-availability)	I,Q,O S	C,M S	Shared
2.2.6.36a/b	STE/M1 fault isolation success/failure/causes	I,O,S G	L,M S	Shared

Table E-1, cont'd

DR Para	Title	Method	Source Group	Writing Responsibility
2.2.6.37	Observed difficult with equipment	I,O,S G	C,L,M S,T	Shared
2.2.6.38	Opinions, adequacy of test set operations, tech manuals, tools sets	I,Q,S G	L,M S,T	Shared
2.2.6.42 2.2.6.46	Type, number of vehicles <u>required</u>	I,O,S G	C,L,M S,T,U	Shared
2.2.6.45	Adequacy of resources to re-arm, refuel/resupply in the field	I,Q,O S,G	C,L,S,T U	Shared
2.2.6.46	See 2.2.6.42 (adequacy, type/number of supply vehicles)			
2.2.6.47	Observed adequacy, type/number of supply personnel	I,O,S G	L,M,S T,U	Total
2.2.6.48	Observed adequacy of operators on hand to operate/maintain supply vehicles	O,S,G	L,M,S	Total
2.2.6.49	Observed problems chambering 120mm round due to moisture	Q,S,G	C,L,S	Total
2.2.6.50	Observed damage to 120mm round from handling	Q,S,G G	S,T	Total
2.2.6.51	Observed casing defects prior to loading 120mm	I,Q,S	C,S,U	Shared
2.2.6.52	Observed 120mm unpacking/repacking problems	I,S	L,U	Shared
2.2.6.56	Problems correcting equipment failures	I,O,D	C,M	Shared
2.2.6.57	Observed new pattern failures	I,O,S G	C,L,M S,T	Shared
2.2.6.58	Record/report all safety related incidents	See 2.1.4.17		

Table E-1, cont'd

DR Para	Title	Method	Source Group	Writing Responsibility
2.3.4.1	Observed adequacy of instructions (TM, FC, etc.) permitting the crew to operate the on-board NBC system effectively	I,Q,O S,G	C,L,S T	Shared
2.3.4.2	Observed adequacy of instructions for readability, executability, and understanding	O	T	Total
2.3.4.3	Observed availability of instructions for each tank crew and company/troop/squadron staff element	Q,O S,G	C,L,S	Total
2.3.4.4	Observed ability of crew to put the instructions to use in an NBC environment	I,O S,G	L,S,T	Shared
2.3.4.5	Observed ability of the crew to use the NBC system properly during a no-notice NBC attack without referring to instructions	I,O S,G	L,S,T	Shared
2.3.4.6	Observed ability of the crew to properly use the backup NBC system	L,O S,G	L,S	Total
2.3.4.7	Adequacy of instructions to state conditions in which NBC system is to be used	I,Q,O S,G	C,L,S T	Total
2.3.4.8	Observed ability of the crew to properly use the system during NBC tactical operations (firing, open hatch, closed hatch, silent watch, road march)	I,O S,G	L,S	Shared
2.3.4 added	Record/report any NBC system related safety incident	I,Q,O S,G	C,L,S M,U,T	Total
2.3.4a (1),(2),(3)	See paras 2.1.4.6; 2.2.6.14; 2.2.6.30 thru 2.2.6.38; and 2.3.4.1 thru 2.3.4.9, above			

Note 1. "OTEA DR" means OTEA Data Requirement, and is carried forward from the OTEA Test Report

Note 2. "Collection Method" identifies which of six collection methodologies was employed. The meaning of the six code letters is as follows:

- I = structured interview by HF staff.
- Q = questionnaire administered by HF staff.
- O = observation of field operations and examination of documentation by HF staff.
- D = debriefing of crew upon mission or task completion (post-ARTEP).
- S = sample Data Collectors observation.
- G = general narrative comment form.

Note 3. "Information Source" refers to six sources of information via six code values, whose meanings are as follows:

- C = tank crew performance.
- L = Unit leaders (Cmds, PLT ldrs, etc.)
- S = sample data collectors.
- T = Test directorate staff personnel.
- M = Maintenance personnel.
- U = Unit supply personnel.

Note 4. "Writing Responsibility." Where the contractor HF&S staff did all of the writing regarding a Data Requirement, the term "total" appears in the column. When both OTEA and contractor staff contributed to the writing, the term "shared" appears.

Table E-2

## Previously Identified HF&amp;S Findings

Finding	Reported in:							
	MI	OT	III	M1E1	OT	II	HEL	FOE
1. Lack of means for removing CO from turret if main NBC system fails. (Outside air source for backup system?)					x		x	
2. Problems removing unfired round from 120mm due to loading ramp design					x		x	
3. Tracking problem, TC's .50 MG. (Controls too sensitive, hard to coordinate.)					x		x	
4. No provision for human waste elimination/disposal during prolonged buttoned-up operations.					x		x	x
5. Inadequate storage for personal gear			x		x		x	x
6. CVC helmet gives inadequate hearing protection, particularly with main NBC system <u>ON</u> .					x			
7. Variable effectiveness of microclimate cooling system.					x		x	x
8. No "autobahn seat" for commander for long-term hatch open travel.					x		x	x
9. Need improved access to "semiready" ammo rack.			x		x			
10. Difficulty using sights with masks on.			x		x		x	
11. Gunner's shoulder padding (on main gun sight) too thin.			x		x		x	
12. Ammo case bases separate from handling (120mm).					x		x	
13. Spontaneous firing of laser rangefinder.					x		x	
14. Difficulty opening/closing hull stowage compartment doors.					x			

Table E-2, cont'd

Finding	Reported in:				
	MI	OT	III	M1E1 OT II	HFEA HEL FOE
15. Difficulty understanding speech over intercom. (Worse when NBC system <u>ON</u> .)				x	x x
16. Slipping of manual breech opening handle (manual operation).					x
17. TC power handle location makes target handoff to gunner slower than required (needs to be raised).		x		x	x
18. No bypass switch to override the automatic engine (low oil pressure) shutdown.		x		x	
19. Driver's steering control adjustment pin is difficult to use and unreliable (vibrates loose).		x		x	x
20. Driver's seat does not give adequate back support.		x		x	x
21. Driver's vision block wipers are ineffective		x		x	x
22. Driver's side vision viewer is marginal.		x		x	x
23. Driver's night vision viewer is marginal.		x		x	x
24. Driver's workspace is too small for most drivers.		x		x	
25. Turret must be traversed to fill front fuel tanks.		x		x	
26. Inadequate brow pad on GPS.				x	
27. Difficulty loading TC's .50 MG.		x		x	
28. Difficulty positioning and aiming loader's MG.				x	x
29. Crew did not know location of NBC air valve; could be blocked, causing shutdown of system.				x	

Table E-3

## HF&amp;S Data Reference Code

Reference Category Field	Data Codes (5 fields)		
	HF&S Primary 1	HF&S OTEA Report Table 2	M1A1 Component 3
Code: 0	Not Applicable	0 N/A	A. GPS
A.	Training & Training Aids (NET)	A. Table 3-55	B. Ballistic Computer
B.	Safety & Health Hazards	B. Table 3-62	C. MRS
C.	Manpower	C. Table 3-63	D. TIS
D.	Crew Station design	D. Table 3-64	E. GASRV
E.	Communications	E. Table 3-65	F. Laser RNGFDR
G.	Controls & Displays	F. Table 3-68	G. Main Gun
H.	Anthropometric & Biomechanics	G.	H. Coax MG
I.	Environment	H. Table 3-87	I. Main NBC system
J.	Personnel	I. Table 3-88	J. Backup NBC system
K.	Maintainability	J. Table 3-89	K. Driver's station
L.	Logistics	K. Table 3-90	L. Loader's station
M.	Other	L. Table 3-92	M. 120mm ammo storage
N.		M. Table 3-93	N. 120mm ammo
O.		N. Not assigned	O. BITE/STE-M1
P.		O. Other	P. Repair parts/tools
Q.		P. Prev Id's problem	Q. Operator's printed instructions
R.	Not assigned	Q. Not assigned	R. Maintainer's printed instructions
S.		R. Not assigned	S. Maintenance organization
T.		S. Health/Safety	T. Supply organization
U.		T. Training	U. Transportation assets
V.			V. Supply assets
W.			W.
X.			X. Not assigned
Y.			Y.
Z.			Z.



Table E-3 cont'd

Reference Category Field	Issue/subissue 4.	Critical Task 5.
Code: 0	Not Applicable	A. Activate gunner's station (TM9-2350-264-10-2)
1.	Calibrate M1A1 Main Gun	B. Prepare GPS for boresighting (TM9-2350-264-10-2)
2.	Operator NBC Protection	C. Prepare ballistic computer/MRS (TM9-2350-264-10-2)
3.	Materiel defect	D. Boresight main gun (FC 17-12-1A1, APP A)
4.	Refuel/rearm	E. Conduct live-fire screening tests (FC 17-12-1A1, APP A)
5.	Replace component	F. Operate main NBC system (TM9-2350-264-10-2)
6.	Evacuate vehicle/component	G. Use protection mask (TM9-2350-264-10-2)
7.	Previously identified problem	H. Operate turret vent (TM9-2350-264-10-2)
8.	New Problem (materiel)	I. Operate NBC backup system (TM9-2350-264-10-2)
9.	Other	J. Rearm/stow 120mm ammo
		K. Transfer 120mm ammo
		L. Pack/unpack 120mm ammo pallets
		M. Chamber 120mm rounds
		N. Isolate faults- STE-M1
		O. Remove/replace components
		P. Correct faults - repair
		Q. Drive
		R. Communicate
		S. PMCS
		T. Operate machineguns
		U. Refuel tank
		V. Handoff target to gunner (TC)
		W. Engage targets - machineguns
		X. Operate microclimate system
		Y. Acquire targets
		Z. Other

Table E-4

## Number of Responses Collected by Category

Comment/Opinion Data								
Interview Data Collected:								
	<u>Staff<sup>a</sup></u>	<u>SDC</u>	<u>TCs<sup>b</sup></u>	<u>Gunners</u>	<u>Drivers</u>	<u>Loaders</u>	<u>Maint</u>	<u>Supply</u>
SQD HQ	2	0	0	0	0	0	7	12
TD PERS	2	15	0	0	0	0	0	0
*M CO	1	0	13	9	11	3	4	0
*I Troop	1	0	1	0	0	0	5	0
**K Troop	1	0	1	0	0	0	5	0
**L Troop	1	0	1	0	0	0	0	0
TOTAL	<u>8</u>	<u>15</u>	<u>21</u>	<u>12</u>	<u>20</u>	<u>11</u>	<u>19</u>	<u>12</u>
Questionnaire Data Collected From:								
			<u>TCs</u>	<u>Gunners</u>	<u>Drivers</u>	<u>Loaders</u>		
M CO			14	10	13	5		
I Troop			7	7	5	6		
K Troop			6	5	5	3		
L Troop			5	3	11	3		
TOTAL			<u>32</u>	<u>27</u>	<u>34</u>	<u>17</u>		

<sup>a</sup>Staff includes commanders<sup>b</sup>TCs include Co/TRP CDR, LY LDR

Note 1. "M" CO and I Troop figures include post-ARTEP debriefings

Note 2. No unit level ARTEPs were conducted for K-L troops. No post-ARTEP troops debriefings were possible; K-L commanders were interviewed as part of the final data collection effort.

Table E-5

Comments on Health and Safety Topics from Crew and Test Directorate Personnel

---

The NBC system exhaust on the left side of the tank is very hot, can cause burns to personnel or possible fires

Dust fills the heater; this might cause dangerous fumes; we don't know yet.

Hoffman device Lanyard-guards on turret rings.

My foot caught in the turret ring.

One can get hurt opening the loader's door.

The extension on the main gun breech causes tripping and bruising your legs.

The ammo doors are too slow opening and closing.

Front fuel caps can't be kept open while fueling; hurt wrist trying to refuel the tank.

The base stub deflector takes up too much room.

You can't keep your balance.

All eight loaders reported instances of dropped rounds or falling while loading, particularly when vehicle is moving over rough terrain.

Make sure turret power is off before you allow anyone on the deck near the main gun. A touch of the gunner or TC's control handle can cause the gun to "bounce" or jump - very dangerous.

---

Table E-6

Comments on Training Topics from Crew and Key Personnel

---

NET was good; instructors were good. (All respondents concurred)

Add a NET for the people who were already 19Ks. It doesn't make sense to retrain those of us who have M1 experience on things that are the same in both the M1 and the M1A1.

Also give some M1A1 training to the scout people; they have to work with us and need to know about the M1A1, particularly the speed factor.

Delete the part about the manuals; all TMs are pretty much the same. (1 leader)

Screen the regiment; don't retrain 19Ks, concentrate on 19Es.

Need more thorough training on the NBC system in NET. (1 TD NCO; 3 TCs)

Need to be trained to break track. (2 drivers)

Need backup NBC system troubleshooting training; it didn't work and we didn't know how to fix it. (1 TC)

Loaders should get more training on EL uncouple; u-ring handle has to be in SAE to open breech, etc. (1 TC)

Delete the DTT course; it is not really necessary. (1 loader)

Have the U-COFT first, then gunnery. It is confusing to alternate. Each crew should go through U-COFT before operating the actual tank. (1 loader, 1 TC)

Maintainers wanted to work on tanks with actual rather than artificially created problems as the hands-on part of NET.

Not enough emphasis on tactical planning before an operation. (Not M1A1 comment)

---

Note. The comments/opinions above were obtained in crew debriefings and end-of-test structured interviews of Test Directorate personnel, company/troop commanders, squadron commander and staff personnel.

Table E-7

Previously Identified Human Factors Deficiencies

---

NBC system does not protect against CO gas.

The NBC system was so loud it interfered with intercom. (2 respondents)  
Radios don't allow operation of two secure nets. (All commanders)  
Radios are inadequate; failed too often.

Need autobahn seat for tank commanders.

Driver's seat is uncomfortable for long periods of use.

Steering control adjustment pin vibrates loose. (1 respondent)

Hard to aim while wearing ventilated facepiece. (Not M1A1 specific problem)

---

Note. The comments/opinions shown above pertain to specific human factors problems identified in previous testing of the M1 or M1A1.

Table E-8

Comments on M1A1 System Components

---

Gun and fire control system are basically OK, but I noticed that there is considerable drift due to the Stab system, which has to be constantly corrected out about every 15 minutes or so. DS maintenance hasn't been able to do anything about this. (All gunners concurred that this is true; they said drift is worse than the M60's 105mm.)

Seat hard to move. (Loader)

Get rid of the loader's seat. (1 loader, 2 troop commanders)

All air must be out of the hydraulics of the 120mm gun to preclude inaccuracies.

---

Note. The comments'and opinions shown above were obtained in crew debriefings and structured interviews.

ENCLOSURE 1  
RESPONSES TO INTERVIEW ITEMS, SUMMED ACROSS PARTICIPANTS

Explanation

In the remaining pages of this appendix, copies of the various interview forms have been reproduced that contain the participant totals and subtotals as they responded to the various items. The responses are given separately for the different categories of respondents.

Raw data - the individual comments and responses by participant to the various interview and questionnaire items - are presented in this document. These responses were input to a dBase III+ and written on a floppy disk by Essex contractor personnel.

#### M1A1 FOLLOW-ON EVALUATION

The purpose of this questionnaire is to identify difficulties you experienced operating the M1A1 tank during the testing just conducted. Please take as much time as you wish and give us narrative comments on subjects you think appropriate. Particular emphasis should be placed upon evaluating the calibration of the main gun system. In order to help us assess your answers, we need some information about your experience in the M1 tank. There are no right or wrong answers to any of the questions. Our purpose is to discover as much as we can about the M1A1 system--good and bad.

S A M P L E



# S A M P L E

## M1A1 FOE DEMOGRAPHIC DATA SHEET PART I

Date: \_\_\_\_\_

1. Player Name: \_\_\_\_\_ 2. SSN: \_\_\_\_\_

3. Position: TC G LDR DR MAINT SUPP

Other (specify) \_\_\_\_\_

4. Tank No. \_\_\_\_\_

5. Height: \_\_\_\_\_ Feet \_\_\_\_\_ Inches 6. Weight: \_\_\_\_\_ Lbs 7. Ages: \_\_\_\_\_ Years

8. Grade/Rank: E- \_\_\_\_\_ O- \_\_\_\_\_ 9. Time in Svc: \_\_\_\_\_ (Yrs) \_\_\_\_\_ (Mos)

10. Unit: (circle one): M60 I trp K trp L trp

		<u>Yrs</u>	<u>Mos</u>
11. Primary MOS: _____	12. Time in Pri MOS: _____		
13. Secondary MOS: _____	14. Time in Sec MOS: _____		
15. Duty MOS: _____	16. Time in Dut MOS: _____		

17. How many weeks have you been working with the M1 tanks? \_\_\_\_\_ (weeks)

18. How many days have you been working with the M1 tanks? \_\_\_\_\_ (days)

19. Please estimate the number of hours of M1A1 training you have had:

- a. Transition \_\_\_\_\_
- b. NET (individual) \_\_\_\_\_
- c. NET (crew/collective) \_\_\_\_\_
- d. OJT \_\_\_\_\_

20. Civilian Education Level: (Circle number that applies)

- |                           |                         |
|---------------------------|-------------------------|
| 1. No High School Diploma | 5. 1-2 years of college |
| 2. GED                    | 6. 3-4 years of college |
| 3. High School Graduate   | 7. College Graduate     |
| 4. Trade School Graduate  | 8. Advanced Degree      |

21. Degree (major) or Trade (specialty): \_\_\_\_\_

22. Do you wear prescribed glasses or contacts \_\_\_\_\_: If yes, why? (To correct what specific vision problem) \_\_\_\_\_

\_\_\_\_\_ Seeing close (reading) \_\_\_\_\_ Seeing far (driving) \_\_\_\_\_ Astigmatism

Other \_\_\_\_\_

S A M P L E

23. If you have ever had an eye injury, please explain:

---

---

24. Have you ever had any hearing problems? \_\_\_\_: If Yes, explain:

---

---

25. Have you ever had any problem with your arms, legs, hands, neck, and/or torso that made it difficult or impossible for you to drive, lift/carry, walk/run, or perform other motor activities \_\_\_\_: If Yes, explain:

---

---

---

26. Have you been sick or injured during or in the three months prior to this test? \_\_\_\_: (Hospitalized or in quarters) If Yes, explain:

---

---

27. If you are taking any prescribed medication, please name it and tell why you are taking it:

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M1A1 FOE  
DEMOGRAPHIC DATA SHEET  
PART II

1. Player No: \_\_\_\_\_
2. Player Name: \_\_\_\_\_
3. SSN: \_\_\_\_\_

OBTAIN FOLLOWING FROM PERSONNEL RECORDS:

ASVAB Score \_\_\_\_\_ GT Score \_\_\_\_\_ EL Score \_\_\_\_\_  
GM Score \_\_\_\_\_ Latest SQT Score \_\_\_\_\_

S A M P L E

TC/GUNNER INTERVIEW

The purpose of this debriefing is to learn if you experienced any problems with the M1A1 concerning main gun boresighting and zeroing; maintaining and supplying the tanks during field operations; using the NBC protection system; and if you observed any safety problems operating, maintaining, or resupplying units because of the M1A1 tank.

I am going to ask a series of questions relating to the functions I just mentioned to guide our discussion; however, you should feel free to bring up any other problems you think are important, even if there are no specific questions asked about that subject.

(Record numbers of Yes/No responses; record the specific comments concerning problems encountered.)

TC-GUNNER

1. (2.1.4.5): Were there any problem with the M1A1 main gun calibration procedures in APP A, FC 17-12-1A1? Yes \_\_\_\_ No 33
2. (2.2.6.14): Are there any of the task performance procedures for main gun operation described in FC 17-12-1A1 that were hard to understand or use? Yes \_\_\_\_ No 33
3. (2.2.6.15): Are the task performance procedures in TM9-2350-264-10-1, 2, and 3 easy to read, understand and use? Yes 22 No 11
4. (2.2.4.6): Overall, is the M1A1's main gun and associated fire control/sighting system reliable, accurate? Yes 33 No \_\_\_\_
5. (2.2.6.21; 2.2.6.22; 2.2.6.23): Were there any problems recovering disabled M1A1 tanks? Yes 7 No 21
6. (2.2.6.26; 2.2.6.29): Did you notice any problems when the heavy equipment transporter \*HET) was used? Yes 5 No 24
7. (2.2.6.30): Were there enough maintenance personnel available? Yes 16 No 17
8. (2.2.6.34): Was the maintenance operation organized so that test equipment, tools, parts and qualified maintenance personnel were always available in forward areas (e.g., company trains areas) when needed to sustain combat operations? Yes 15 No 18
9. (2.2.6.38): Did the M1A1 built-in test equipment (BITE) in the control computer work correctly? Yes 27 No 6
10. (2.2.6.42; 2.2.6.45): Were the forward resupply operations adequate to keep your tank supplied with fuel, rations and ammo? Yes 15 No 18
11. (2.2.6.47; 2.2.6.48): Did you observe any shortage of supply personnel or trucks, etc., needed to keep supplies moving forward? Yes 6 No 27
12. (2.3.4.1; 2.3.4.2): Were you able to operate the NBC system by using the operating instructions in TM9-2350-264-10-1, 2 and 3? Yes 33 No \_\_\_\_
13. (2.3.4.7): Was your unit's NBC SOP effective? Yes 26 No 3
14. (2.1.4.17; 2.2.6.58; 2.3.4): Do you know of any noise, vibration, smoke/toxic fumes/gas, electrical shock, heat/cold, mechanical (moving parts, hatch locks, wire/cables, etc.), or structural (edges, ledges, sharp corners, etc.) safety hazards in the M1A1 or its support equipment? Yes 24 No 2

15. (2.1.4.17; 2.2.6.58; 2.3.4): Have you been injured, or do you know of a person who has been injured, while participating in this test?  
Yes 1 No 32
16. (P): Were there any operational task performance problems due to difficulty communicating with other crew members because of engine/NBC system noise levels? Yes 1 No 22
17. (T): What should be added to the training program?
18. (T): What would you delete from the training program?
19. (T): Are there any changes you would recommend for the M1A1 training program? Yes 5 No 28
20. (T): Are you aware of any ARTEP task for which you or any other persons were not sufficiently trained? Yes 3 No 30

## DRIVER DEBRIEFING

1. (P): Do you consider the seat satisfactory for driving for extended periods? Yes 6 No 14
2. (P): Could you see well enough to drive safely using the vision blocks and/or the night viewer? Yes 11 No 9
3. (P): Was there sufficient interior space for you to perform all your driving tasks while buttoned-up? Yes 20 No
4. (P): Did you have enough storage space for your gear? Yes 3 No 17
5. (P): Did your steering control adjustment pin cause trouble?  
Yes 1 No 15
6. (2.2.6.15): Are the task performance procedures in TM9-2350-264-10-1, 2, 3 easy to read, understand and use? Yes 20 No
7. (2.2.6.21; 2.2.6.22; 2.2.6.23): Did you observe any problems recovering disabled M1A1 tanks? Yes     No 20
8. (2.2.6.26; 2.2.6.29): Did you observe any problems with the heavy equipment transporter (HET) during the test? Yes     No 20
9. (2.2.6.30): Were there enough maintenance personnel available?  
Yes 13 No 7
10. (2.2.6.34): Was the maintenance operation organized so that test equipment, tools, parts, and qualified maintenance personnel were always available in forward areas (e.g., company trains area) when needed to sustain combat operations? Yes 13 No 7
11. (2.2.6.38): Did the M1A1 built-in problem warnings (lights) work correctly? Yes 15 No 5
12. (2.2.6.42; 2.2.6.45): Were the forward resupply operations effective in keeping your tank supplied with fuel, rations and ammo? Yes 11 No 9
13. (2.2.6.47; 2.2.6.48): Did you observe any shortage of supply personnel or trucks, etc., needed to keep supplies moving forward? Yes     No 20
14. (2.3.4.1; 2.3.4.2): Were the NBC system operating instructions in TM9-2350-264-10-1, 2, & 3 easy to read and understand? Yes 20 No
15. (2.3.4.7): Was your Unit SOP regarding NBC system use sufficient?  
Yes 11 No 4

16. (2.1.4.17; 2.2.6.58; 2.3.4): Do you know of any noise, vibration, smoke/toxic fumes/gas, electrical shock, heat/cold, mechanical (moving parts, hatch locks, wire/cables, etc.), or structural (edges, ledges, sharp corners, etc.) safety hazards in the M1A1 or its support equipment? Yes 12 No 8
17. Have you been injured, or do you know of a person who has been injured, while participating in this test? Yes      No 20
18. (P): Were there any operational task performance problems due to difficulty communicating with other crew members because of engine/NBC system noise levels? Yes 8 No 12
19. (T) What should be added to the training program?
20. (T) What would you delete from the training program?
21. (T) Are there any changes you would recommend for the M1A1 training program? Yes 3 No 17
22. (T) Are you aware of any ARTEP task for which you or any other persons were not sufficiently trained? Yes 3 No 17



## LOADER DEBRIEFING

1. (2.2.6.49): Did 120mm ammo cause any chambering problems? Yes 1 No 10
2. (2.2.6.50): Did you observe any damage to 120mm ammunition due to handling? Yes      No 11
3. (2.2.6.51): Did you find any defective 120mm round casings before chambering a round? Yes      No 11
4. (P): Were there any problems inserting or removing 120mm rounds from any of the stowage tubes? Yes      No 11
5. (P): Was there enough floor space for keeping a good solid footing or maintaining your balanced while loading the main gun? Yes      No 10
6. (P): Did loading/ammo handling cause problems while wearing MOPP IV gear? Yes      No 11
7. (2.2.6.34): Was the maintenance operation organized so that test equipment, tools, parts and qualified maintenance personnel were always available in forward areas (e.g., company trains area) when needed to sustain combat operations? Yes 10 No 1
8. (2.2.6.42; 2.2.6.45): Were the forward resupply operations adequate to keep your tank supplied with fuel, rations and ammo? Yes 6 No 5
9. (2.2.6.47; 2.2.6.48): Did you observe any shortage of supply personnel or trucks, etc., need to keep supplies moving forward? Yes      No       
Not observed 11
10. (2.3.4.1; 2.3.4.2): Were the NBC system operating instructions in TM9-2350-264-10-1, 2, & 3 easy to read and understand? Yes 11 No
11. (2.3.4.7): Was your Unit SOP regarding NBC system use satisfactory? Yes 8 No      Don't know 3
12. (2.1.4.17; 2.2.6.5; 8; 2.3.4): Do you know of any noise, vibration, smoke/toxic fumes/gas, electrical shock, heat/cold, mechanical (moving parts, hatch locks, wire/cables, etc.,) or structural (edges, ledges, sharp corners, etc.) safety hazards in the M1A1 or its support equipment? Yes 3 No 8
13. Have you been injured, or do you know of a person who has been injured, while participating in this test? Yes 6 No 4
14. (P): Were there any operational task performance problems due to difficulty communicating with other crew members because of engine/NBC system noise levels? Yes 1 No 9

15. (T) What should be added to the training program?
16. (T) What would you delete from the training program?
17. (T) Are there any changes you would recommend for the M1A1 training program? Yes 2 No 9
18. (T) Are you aware of any ARTEP task for which you or any other persons were not sufficiently trained? Yes      No 11

KEY UNIT LEADERS/TEST DIRECTORATE  
STRUCTURED INTERVIEW OUTLINE

The purpose of this interview is to record any problems you identified during the follow-on evaluation of the M1A1.

Areas of concern are:

- a. Main gun calibration procedures.
- b. Maintaining and resupplying M1A1 units.
- c. Using the NBC protection system of the M1A1.
- d. Significant safety hazards/problems you have identified associated with operating, maintaining, and resupplying M1A1 equipped units.

I am going to ask a series of questions relating to the functional areas just mentioned; but these are not intended to limit your discussion of problems. Please feel free to discuss any problem you believe important, even if there are not specific questions about that subject.

(Record numbers of Yes/No responses; record the specific comments concerning problems encountered.)

UNIT/TD INTERVIEW

1. (2.1.4.5): Did you note any specific deficiencies in the new equipment training (NET) given for the M1A1? Yes 9 No 13
2. (2.1.4.5): Could the crew understand and follow the task performance instructions in App A, FC 17-12-1A1 without difficulty? Yes 22 No 0
3. (2.1.4.5): Were crews able to perform the main gun calibration to time and accuracy standards? Yes 19 No 3
4. (2.1.4.6): Did you note any situations in which targets were missed because of an M1A1 main gun system accuracy problem? Yes 9 No 15
5. (M): Did you note any problems in the areas of command, control and communications caused by the M1A1 or its support requirements? Yes 17 No 6
6. (2.2.6.21; 2.2.6.22; 2.2.6.23): Did you note any problems recovering M1A1? Yes 7 No 15
7. Did you note any HET operations problems? Yes 13 No 9

Was the squadron's/troop's maintenance operation effective in terms of:

8. (2.2.6.30): Personnel authorization? Yes 10 No 13
9. (2.2.6.30; 2.2.6.31; 2.2.6.32): Test equipment? Yes 7 No 16
10. (2.2.6.3; 0; 2.2.6.31; 2.2.6.32): Tools (type and availability)? Yes 8 No 15
11. (2.2.6.3; 0; 2.2.6.31; 2.2.6.32): Spares and replacements? Yes 2 No 21
12. (2.2.6.42; 2.2.6.45): Were the forward resupply operations able to sustain the required tempo of combat operations. Yes 6 No 17
13. (2.2.6.47; 2.2.6.48): Were there any TOE deficiencies in the combat service support resources caused by the change to the M1A1? Yes 12 No 11

14. (2.2.6.49; 2.2.6.51; 2.2.6.52): Do you know of any problems caused by the design, packaging, handling, or transportation of the "caseless" 120mm main gun ammunitions? Yes 2 No 17
15. (2.3.4.1; 2.3.4.2): Did any crews have difficulty reading, understanding, or using the NBC system operating instructions in TM9-2350-264-1, 2 & 3? Yes 7 No 16
16. (2.3.4.7): Did any crews have problems complying with unit SOP regarding NBC equipment employment? Yes 6 No 6 (11 "had no SOP")
17. (2.1.4.17; 2.2.6.58; 2.3.4): Do you know of any noise, vibration, smoke/toxic fumes/gas, electrical shock, heat/cold, mechanical (moving parts, hatch locks, wire/cables, etc.), or structural (edges, ledges, sharp corners, etc.) safety hazards in the M1A1 or its support equipment? Yes 13 No 10
18. Are you aware of any injuries to personnel during this FOE period attributable to the M1A1 or its associated support equipment? Yes 0 No 23
19. (P): Were there any operational task performance problems due to difficulty communicating with other crew members because of engine/NBC system noise levels? Yes 2 No 21
20. (T): What should be added to the training program?  
"Nothing" 5  
"More TTS training" 1  
"More extensive individual training" 1  
"Don't know" 1
21. What would you delete from the training program?  
"Nothing" 17  
"Delete DTT" 2  
"Don't know" 3
22. (T): Are there any changes you would recommend for the M1A1 training programs? Yes 4 No 19
23. (T): Are you aware of any ARTEP task for which you or any other persons were not sufficiently trained? Yes 9 No 14

## MAINTAINER'S INTERVIEW GUIDE

The purpose of this interview is to try to identify problems and deficiencies which have occurred in maintenance support operations because of the changeover to the M1A1 tank and its associated support equipment.

Questions will be asked about:

- a. Adequacy of maintenance personnel authorizations.
- b. Adequacy of maintenance organization/procedures.
- c. Sufficiency of test equipment, tools, and parts resupply.
- d. Sufficiency of maintenance publications.

The questions are intended to guide the discussion. If you think of something else that needs to be brought out, please don't hesitate; all information we can get helps.

1. (2.2.6.21; 2.2.6.22; 2.2.6.23): Did you note any problems recovering M1A1? Yes 10 No 9

2. Did you note any HET operations problems? Yes 5 No 14

Was the maintenance operation satisfactory in terms of:

3. (2.2.6.30): Personnel authorization? Yes 16 No 3

4. (2.2.6.30; 2.2.6.31; 2.2.6.32): Test equipment? Yes 2 No 17

5. (2.2.6.30; 2.2.6.31; 2.2.6.32): Tools (type and availability)?  
Yes 10 No 9

6. (2.2.6.30; 2.2.6.31; 2.2.6.32): Spares and replacements? Yes 13 No 6

7. (2.2.6.34): Number and types of maintenance support vehicles?  
Yes 8 No 11

8. (2.2.6.32; 2.2.6.36): Are the M1A1 fault indicator lights, gauges, etc., adequate? Yes 12 No 7

9. Do the built-in warning lights give false indications? Yes 12 No 7

10. (2.2.6.32): Do the crews usually react correctly to the warning indicators? Yes 19 No 0

11. (2.2.6.32; 2.2.6.36 a/b)): Does the following BITE indications help you diagnose and isolate malfunctions quickly? Yes 19 No 0

12. (2.2.6.35 a/b): Is the STE/M1 test equipment you have sufficient to support sustained operations? Yes 6 No 13

13. (2.2.6.35 a/b): Were there any significant failures of the STE/M1?  
Yes 18 No 1

14. (2.2.6.38): Are there any problems with the maintenance manuals you have been furnished for the M1A1? Yes 11 No 8

15. (2.2.6.30; 2.2.6.27; 2.2.6.38): Is there anything that needs to be changed about organization, procedures, equipment or supply operations to improve the effectiveness of M1A1 maintenance? Yes 16 No 3

16. Are you aware of any injuries to personnel during this FOE period attributable to the M1A1 or its associated support equipment?  
Yes 7 No 12



### MAINTAINER SUPPLEMENTAL STE-M1A1 QUESTIONS

In addition, maintenance personnel were asked the following questions specifically concerning STE-M1A1:

1. Have you used the STE since the M1A1's arrived? Yes 19 No

Comments:

None

2. Is the STE usually available at your field maintenance sites when you need it? Yes 19 No

Comments:

None

3. What alternate troubleshooting procedures are available to you?

Comments:

Breakout box; Swing test

4. What is your preferred method of troubleshooting?

Comments:

STE-M1 (13)  
Breakout box (6)

5. What do you like about the STE?

Comments:

It is only comprehensive testing available (1 maintainer).

6. What is wrong with the STE?

Comments:

Too bulky (19).  
Too complex and time consuming to hook up and run a test (6).  
Doesn't easily isolate a specific fault component (23).  
Gives false indications (about 50% said 80% accurate; 50% said 25-30% accurate).

7. What percent of the time does the STE correctly isolate a faulty component?

Comments:

About 75-80% of the time (50% of respondents).

About 25-30% of the time (50% of respondents).

8. Overall, does the STE make it faster or slower to identify the causes of a malfunction?

Comments:

Faster (because it is the only complete troubleshooting method).

9. What training did you receive on use of the STE?

Comments:

About 2 weeks in NET.

## CAVALRY SQUADRON SUPPLY PERSONNEL INTERVIEW

The purpose of this interview is to record any problems you identified during the follow-on evaluation of the M1A1.

Areas of concern are:

- a. Organization of supply operations.
- b. Personnel staffing of supply elements.
- c. Supply element equipment authorizations.
- d. Resupply operational problems.

I am going to ask a series of questions relating to your squadron's supply functions; these questions are intended to help recall any difficulties you may have observed during resupply operations, but are not intended to limit what you have to say in any way. Please feel free to bring up any problem you believe important, even if there are no specific questions about that subject.

(Record numbers of Yes/No responses; record the specific comments concerning problems encountered.)

TOTAL SHEET

CAVALRY SQUADRON SUPPLY PERSONNEL INTERVIEW

1. (2.2.6.42; 2.2.6.45; 2.2.6.46): Did you sections have enough trucks to keep the unit's supplies moving forward adequately during field operations?

a. Ammunition Yes 11 No 1  
b. Fuel Yes 6 No 6  
c. Rations N/A

2. (2.2.6.42; 2.2.6.46): Are your transportation assets satisfactory during field operations? Yes 5 No 7

Are your TO&E supply section personnel authorizations satisfactory in terms of:

3. (2.2.6.47): Number of supply personnel? Yes 0 No 12

4. (2.2.6.47): MOSs of supply personnel? Yes 12 No 0

5. (2.2.6.47): Did you actually have enough people present for duty?  
Yes 7 No 5

6. (2.2.6.49): Do you know of any instances in which 120mm rounds could not be chambered in the gun? Yes 12 No 0

7. (2.2.6.50): Do you know of any instances in which 120mm rounds were damaged in handling? Yes 12 No 0

8. (2.2.6.51): Did you find any 120mm ammo which had defective casings?  
Yes 5 No 7

9. (2.2.6.52): Were there any unpacking or repacking problems with 120mm ammo? Yes 5 No 7

10. (2.2.6.56): Did any of the M1A1 associated equipment or supplies cause new problems for supply personnel? Yes 5 No 7

11. Is there anything about the way your supply section is organized, staffed, equipped, or operated that should be changed because of the squadron being equipped with the M1A1? Yes 12 No 0

12. Are you aware of any injuries to personnel during this FOE period attributable to the M1A1 or its associated support equipment?  
Yes 0 No 12

ENCLOSURE 2

COMPLETE RESPONSE DATA FROM END-OF-TEST QUESTIONNAIRES

## M1A1 FOLLOW-ON EVALUATION

The purpose of this questionnaire is to identify difficulties you experienced operating the M1A1 tank during the testing just conducted. Please take as much time as you wish and give us narrative comments on subjects you think appropriate. Particular emphasis should be placed upon evaluating the calibration of the main gun system. In order to help us assess your answers, we need some information about your experience in the M1 tank. There are no right or wrong answers to any of the questions. Our purpose is to discover as much as we can about the M1A1 system--good and bad.

M1A1 FOE  
QUESTIONNAIRE ID DATA SHEET  
PART II

1. Player Name: \_\_\_\_\_ (optional)
2. SSN: \_\_\_\_\_ (optional)
3. Tank No: \_\_\_\_\_

# TANK COMMANDERS

Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1
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Please use the above scale to rate the ease of performing the following tasks by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
1. Perform prefiring PMCS (Table 2-2, TM9-250-264-10-1). (2.2.6.14)	0	19	9	4	0	0	32	4.47
2. Perform prepare-to-fire checks M1A1 Prepare to Fire Checklist, USAARMS, 1986). (2.1.4.5)	0	19	9	3	1	0	32	4.44
3. Perform prepare to calibrate tasks (APP.A, FC 17-12-1A1). (2.1.4.5)	1	14	14	2	1	0	31	4.32
4. Install M27 muzzle boresight device (MBD). (2.1.4.5; 2.1.4.6)	0	17	10	4	1	0	32	4.34
5. Lay M27 MBD on the target aiming point. (2.1.4.5; 2.1.4.6)	0	16	11	5	0	0	32	4.34
6. Move the GPS aiming dot to the boresight aiming point. (2.1.4.5; 2.1.4.6)	2	16	12	2	0	0	32	4.50
7. Check by moving and relaying gun tube ("G" pattern check). (2.1.4.5; 2.1.4.6)	0	18	12	2	0	0	32	4.50
8. Identify causes of faults found during "G" pattern test. (2.1.4.5; 2.1.4.6)	2	6	12	9	3	0	30	3.70
9. Correct boresight system faults. (2.1.4.5; 2.1.4.6; 2.2.6.56)	0	6	12	9	5	0	32	3.59
10. Correct boresight procedure errors.	0	6	16	5	5	0	32	3.71



# TANK COMMANDERS

	Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
11. Verify boresight M27 inserted 180° from original orientation, (2.1.4.5; 2.1.4.6)	0	11	17	2	2	0	32	4.16
12. Determine average of the two AZ/EL readings. (2.1.4.5; 2.1.4.6)	0	10	15	6	1	0	32	4.06
13. Adjust GPS reticle to the average AZ/EL. (2.1.4.5; 2.1.4.6)	0	12	18	2	0	0	32	4.31
14. Enter/verify correct data in the CCP. (2.1.4.5; 2.1.4.6)	0	15	15	2	0	0	32	4.41
15. Adjust GAS to correspond to GPS. (2.1.4.5; 2.1.4.6)	0	17	12	3	0	0	31	4.44
16. Adjust TIS reticle. (2.1.4.5; 2.1.4.6)	1	17	11	3	0	0	31	4.44
17. Boresight the MRS. (2.1.4.5; 2.1.4.6)	0	18	10	4	0	0	32	4.38
18. Enter manual CCP inputs. (2.1.4.5; 2.1.4.6)	1	18	11	2	0	0	32	4.38
19. Fire main gun; confirm zero. (2.1.4.5; 2.1.4.6)	0	15	16	1	0	0	32	4.44
20. Adjust/operate GPS. (2.1.4.5; 2.1.4.6)	0	18	14	0	0	0	32	4.56
21. Adjust operate TIS. (2.1.4.5; 2.1.4.6)	0	16	13	3	0	0	32	4.41
22. Adjust/operate GAS. (2.1.4.5; 2.1.4.6)	0	16	14	2	0	0	32	4.44
23. Range with laser rangefinder. (2.1.4.5; 2.1.4.6)	0	14	11	7	0	0	32	4.22

# TANK COMMANDERS

	Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
24. Range with optical rangefinder. (2.1.4.5; 2.1.4.6)	8	9	8	7	0	0	24	4.08
25. Adjust using BOT technique. (2.1.4.5; 2.1.4.6)	11	6	7	6	2	0	0	3.41
26. Track and lead using power mode. (2.1.4.5; 2.1.4.6)	1	13	13	5	0	0	31	4.26
27. Track and lead, manual controls. (2.1.4.5; 2.1.4.6)	3	2	10	10	7	0	32	2.94
28. Aim with protective mask/ ventilated facepiece on. (P)	0	4	6	12	8	2	32	3.06
29. Maintain 120mm gun. (2.1.6.31)	0	11	13	7	1	0	32	4.06
30. Unload unfired 120mm rounds from guns. (P)	0	8	15	5	4	0	32	3.84
31. Maintain machineguns. (2.1.6.31)	0	10	17	5	0	0	32	4.16

Did you have difficulty performing any of the above tasks? Yes \_\_\_\_ No \_\_\_\_  
 If "Yes," what was the problem? (Comments extracted for use in other  
 displays.)

# TANK COMMANDERS

Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1
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Please use the above scale to rate the ease of performing the following tasks by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
32. Main gun calibration procedures. (2.1.4.6)	0	5	25	2	0	0	32	4.09
33. Main gun hitting performance. (2.1.4.6)	1	12	18	1	0	0	31	4.35
34. Coax MG hitting performance. (2.1.4.6) (P)	0	14	17	1	0	0	32	4.41
35. TC's .50 cal MG hitting performance. (2.1.4.6) (P)	3	12	13	3	1	0	29	4.24
36. M1A1 operation instructions (TM9-2350-264-10-1, 2, & 3). (2.2.6.14; 2.2.6.38)	0	11	19	2	0	0	32	4.28
37. M1A1 crew maintenance instructions (TM9-2350-264-10-1, 2, & 3). (2.2.6.38)	0	10	18	3	1	0	32	4.16
38. M88A1 for M1A1 recovery operations. (2.2.6.23)	6	2	13	7	2	2	26	3.42
39. Cavalry squadron organizational maintenance capabilities. (2.2.6.30)	0	2	15	6	5	4	32	3.13
40. Direct support maintenance opera- tions during the test period. (2.2.6.30; 2.2.6.31)	1	3	22	2	3	1	31	3.55
41. Heavy equipment transport (HET) operations. (2.2.6.29)	1	4	21	4	1	1	31	3.84
42. Standardized test equipment (STE/M1). (2.2.6.32; 2.2.6.38)	1	4	18	4	2	3	31	3.58

# TANK COMMANDERS

	Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
43. Tool types available to you. (2.2.6.38)	0	3	19	7	2	1	32	3.66
44. Tool quantities furnished. (2.2.6.38)	0	2	21	6	2	1	32	3.66
45. Availability of support equipment. (2.2.6.38)	1	3	21	5	2	1	31	3.84
46. Field resupply (ammo, fuel, rations) operations. (2.2.6.47)	1	0	17	10	1	3	31	3.32
47. Types/numbers of resupply personnel. (2.2.6.42)	1	3	21	5	0	2	31	3.74
48. Types/numbers of resupply vehicles. (2.2.6.42)	0	0	18	8	2	4	32	3.25
49. Ability of 120mm to meet field conditions. (2.2.6.50)	0	8	21	2	1	0	32	4.13
50. NBC system operating instructions. (2.3.4.1; 2.3.4.2; 2.3.4.3)	0	9	17	5	1	0	32	3.91
51. NBC system unit SOP. (2.3.4.7; 2.3.4.8)	3	6	17	5	0	1	29	3.93
52. Cooling capabilities of the "micro-climate" system. (P)	0	6	20	6	0	0	32	4.00
53. Procedures for equipment problem identification. (2.2.6.37)	0	4	22	4	1	1	32	3.84
54. Procedures for correcting/ repairing failures. (2.2.6.56)	0	5	22	4	1	0	32	3.81
55. Communicating over intercom, NBC system <u>OFF</u> . (P)	0	9	23	0	0	0	32	4.28
56. Communicating over intercom, NBC system <u>ON</u> . (P)	0	7	21	4	0	0	32	4.09

# GUNNERS

Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1
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Please use the above scale to rate the ease of performing the following tasks by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
1. Perform prefiring PMCS (Table 2-2, TM9-250-264-10-1). (2.2.6.14)	0	11	12	4	0	0	27	4.26
2. Perform prepare-to-fire checks (M1A1 Prepare to Fire Checklist, USAARMS, 1986). (2.1.4.5)	0	9	16	2	0	0	27	4.26
3. Perform prepare to calibrate tasks (APP.A, FC 17-12-1A1). (2.1.4.5)	0	7	12	8	0	0	27	3.96
4. Install M27 muzzle boresight device (MBD). (2.1.4.5; 2.1.4.6)	0	16	9	2	0	0	27	4.52
5. Lay M27 MBD on the target aiming point. (2.1.4.5; 2.1.4.6)	0	11	14	1	1	0	27	4.30
6. Move the GPS aiming dot to the boresight aiming point. (2.1.4.5; 2.1.4.6)	0	14	13	0	0	0	27	4.52
7. Check by moving and relaying gun tube ("G" pattern check). (2.1.4.5; 2.1.4.6)	0	12	14	0	1	0	27	4.37
8. Identify causes of faults found during "G" pattern test. (2.1.4.5; 2.1.4.6)	0	4	14	9	0	0	27	3.81
9. Correct boresight procedure errors. (2.1.4.5; 2.1.4.6; 2.2.6.56)	0	3	13	10	1	0	27	3.67
10. Correct boresight procedure errors. (2.1.4.5; 2.1.4.6)	0	3	13	10	1	0	27	3.67

# GUNNERS

	Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
11. Verify boresight M27 inserted 180° from original orientation. (2.1.4.5; 2.1.4.6)	0	8	14	5	0	0	27	4.11
12. Determine average of the two AZ/EL readings. (2.1.4.5; 2.1.4.6)	0	12	11	4	0	0	27	4.30
13. Adjust GPS reticle to the average AZ/EL. (2.1.4.5; 2.1.4.6)	0	9	14	4	0	0	27	4.19
14. Enter/verify correct data in the CCP. (2.1.4.5; 2.1.4.6)	0	14	11	2	0	0	27	4.44
15. Adjust GAS to correspond to GPS. (2.1.4.5; 2.1.4.6)	0	12	9	6	0	0	27	4.22
16. Adjust TIS reticle. (2.1.4.5; 2.1.4.6)	0	13	10	4	0	0	27	4.33
17. Boresight the MRS. (2.1.4.5; 2.1.4.6)	0	13	9	2	3	0	27	4.19
18. Enter manual CCP inputs. (2.1.4.5; 2.1.4.6)	0	15	9	2	1	0	27	4.41
19. Fire main gun; confirm zero. (2.1.4.5; 2.1.4.6)	0	11	12	2	2	0	27	4.19
20. Adjust/operate GPS. (2.1.4.5; 2.1.4.6)	0	12	11	4	0	0	27	4.30
21. Adjust operate TIS. (2.1.4.5; 2.1.4.6)	0	11	12	3	1	0	27	4.22
22. Adjust/operate GAS. (2.1.4.5; 2.1.4.6)	0	10	9	6	2	0	27	4.00
23. Range with laser rangefinder.	0	10	10	6	1	0	27	4.07

# GUNNERS

Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1
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	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
24. Range with optical rangefinder. (2.1.4.5; 2.1.4.6)	0	3	3	11	10	0	27	2.96
25. Adjust using BOT technique. (2.1.4.5; 2.1.4.6)	2	4	6	13	2	0	25	3.48
26. Track and lead using power mode. (2.1.4.5; 2.1.4.6)	0	9	11	6	1	0	27	3.85
27. Track and lead, manual controls. (2.1.4.5; 2.1.4.6)	0	2	7	14	4	0	27	3.26
28. Aim with protective mask/ ventilated facepiece on (P).	0	2	7	13	5	0	27	3.22
29. Maintain 120mm gun. (2.1.6.31)	0	5	11	9	2	0	27	3.70
30. Unload unfired 120mm rounds from guns. (P).	0	6	9	8	3	1	27	3.59
31. Maintain machineguns. (2.1.6.31)	0	8	12	7	0	0	27	4.04

Did you have difficulty performing any of the above tasks? Yes \_\_\_\_ No \_\_\_\_  
 If "Yes," what was the problem? (Comments extracted for use in other  
 displays.)

# GUNNERS

Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1
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Please use the above scale to rate the effectiveness of the following factors of the M1A1 system by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
32. Main gun calibration procedures. (2.1.4.6)	0	6	20	1	0	0	27	4.19
33. Main gun hitting performance. (2.1.4.6)	1	12	13	1	0	0	26	4.42
34. Coax MG hitting performance. (2.1.4.6) (P)	0	15	10	2	0	0	27	4.48
35. TC's .50 cal MG hitting performance. (2.1.4.6) (P)	3	5	16	3	0	0	24	4.08
36. M1A1 operation instructions (TM9-2350-264-10-1, 2, &3). (2.2.6.14; 2.2.6.38)	0	11	16	0	0	0	27	4.41
37. M1A1 crew maintenance instructions (TM9-2350-264-10-1, 2, &3). (2.2.6.38)	0	9	17	1	0	0	27	4.30
38. M88A1 for M1A1 recovery operations. (2.2.6.23)	4	4	15	4	0	0	23	4.00
39. Cavalry squadron organizational maintenance capabilities. (2.2.6.30)	1	1	12	11	0	2	26	3.38
40. Direct support maintenance opera- tions during the test period. (2.2.6.30); 2.2.6.31)	3	2	12	8	1	1	24	3.54
41. Heavy equipment transport (HET:) operations. (2.2.6.29)	1	0	20	5	1	0	26	3.73
42. Standardized test equipment (STE/M1). (2.2.6.32; 2.2.6.38)	2	1	17	5	1	1	25	3.64



# GUNNERS

	Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
43. Tool types available to you. (2.2.6.38)	0	2	16	8	0	1	27	3.67
44. Tool quantities furnished. (2.2.6.38)	0	2	18	7	0	0	27	3.81
45. Availability of support equipment. (2.2.6.38)	0	1	15	10	1	0	27	3.59
46. Field resupply (ammo, fuel, rations) operations. (2.2.6.47)	0	3	16	7	1	0	27	3.78
47. Types/numbers of supply personnel (2.2.6.47)	1	0	21	5	0	0	26	3.81
48. Types/numbers of resupply vehicles. (2.2.6.42)	1	1	18	7	0	0	26	3.96
49. Ability of 120mm ammo to meet field conditions. (2.2.6.50)	2	1	24	0	0	0	25	4.04
50. NBC system operating instructions. (2.3.4.1; 2.3.4.2; 2.3.4.3)	0	2	22	3	0	0	27	3.9;6
51. NBC system unit SOP. (2.3.4.7; 2.3.4.8)	2	0	19	6	0	0	25	3.76
52. Cooling capabilities of the "micro-climate" system. (P)	0	3	18	5	0	1	27	3.81
53. Procedures for equipment problem identification. (2.2.6.37)	0	2	20	5	0	0	27	3.89
54. Procedures for correcting/ repairing failures. (2.2.6.56)	0	1	21	4	1	0	27	3.81
55. Communicating over intercom, NBC system <u>OFF</u> . (P)	0	3	21	2	0	1	27	3.93
56. Communicating over intercom, NBC system <u>ON</u> . (P)	0	2	22	2	0	1	27	3.89

# DRIVERS

Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1
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Please use the above scale to rate the ease of performing the following task by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
1. Perform driver PMCS. (2.2.6.31; 2.2.6.37)	0	10	16	8	0	0	34	4.06
2. Check battery fluid level. (P)	0	14	14	4	2	0	34	4.18
3. Check/replace filters in gas particulate units. (P)	16	1	2	12	2	1	18	3.00
4. Fill front fuel tanks. (P)	0	0	6	13	13	2	34	2.68
5. Driving, MOPP IV gear on (P)	0	2	3	10	13	6	34	2.47
6. Driving, MOPP II gear on. (P)	0	4	13	10	5	2	34	3.35
7. Driving, using night vision viewer at night. (P)	0	3	8	17	6	0	34	3.24
8. Driving, using night vision viewer at night while main gun is firing. (P)	1	0	2	15	12	4	33	2.45
9. Seeing outside through the side vision blocks. (P)	0	2	8	14	9	1	34	3.03
10. Driving with hatch open, (2.2.6.37)	1	26	2	3	1	1	33	4.55
11. Driving with hatch closed. (P)	0	2	15	13	4	0	34	3.44
12. Reading, understanding and using TM9-2350-264-10-1, 2, & 3). (2.2.6.14; 2.2.6.38)	0	13	17	4	0	0	34	4.26
13. Operating hull stowage compartment doors. (P)	2	4	7	8	10	3	32	2.97
14. Understanding and using NBC system operating instructions. (2.3.4.1; 2.3.4.2)	1	8	15	10	0	0	33	3.94

# DRIVERS

Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1
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Please use the above scale to rate the effectiveness of the following factors of the M1A1 system by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
15. Durability of M1A1 roadwheels. (P)	0	11	21	2	0	0	34	4.26
16. Durability of M1A1 track. (P)	1	2	14	5	5	7	33	2.91
17. M1A1 crew maintenance instructions (TM9-2350-264-10-1, 2, & 3). (2.2.6.14; 2.2.6.38)	0	8	25	1	0	0	34	4.21
18. M1A1 built-in test equipment/fault indicators. (2.2.6.36a/b; 2.2.6.37; 2.2.6.38)	0	9	17	6	1	1	34	3.94
19. M88A1 for M1A1 recovery operations. (2.2.6.23)	7	2	13	9	1	2	27	3.44
20. Cavalry squadron organizational maintenance capabilities. (2.2.6.30)	1	0	14	11	4	4	33	3.06
21. Direct support maintenance operations during the test period. (2.2.6.30; 2.2.6.31)	0	0	20	6	3	5	34	3.21
22. Heavy equipment transport (HET) operations. (2.2.6.26; 2.2.6.29)	0	8	20	5	1	0	34	4.03
23. Standardized test equipment (STE/M1). (2.2.6.36a/b)	5	0	17	7	2	3	29	3.31
24. Tool types available to you. (2.2.6.38)	0	4	22	3	3	2	34	3.68
25. Tool quantities available. (2.2.6.38)	0	3	20	7	2	2	34	3.59

# DRIVERS

	Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
26. Availability of support equipment. (2.2.6.34)	2	0	20	8	3	1	32	3.47
27. Field resupply (ammo, fuel, rations) operations. (2.2.6.45)	0	4	20	8	2	0	34	3.76
28. Types/numbers of supply personnel. (2.2.6.47)	4	0	19	8	1	2	30	3.47
29. Types/numbers of resupply vehicles. (2.2.6.46)	2	1	21	7	1	2	32	3.56
30. Ability of 120mm ammo to meet field conditions. (2.2.6.50)	1	6	22	5	0	0	33	4.03
31. NBC system unit SOP. (2.3.4.1; 2.3.4.2)	2	7	19	5	0	1	32	3.97
32. Cooling capabilities of the "microclimate" system. (P)	3	10	16	4	0	1	31	4.10
33. Procedures for equipment problem identification. (2.2.6.37)	2	3	24	4	0	1	32	3.88
34. Procedures for correcting/repairing failures. (2.2.6.56)	1	1	24	6	2	0	33	3.73
35. Communicating over intercom, NBC system <u>OFF</u> . (P)	0	7	20	4	2	1	34	3.88
36. Communicating over intercom, NBC system <u>ON</u> . (P)	1	0	20	8	0	5	33	3.30

# LOADERS

Not applicable NA	Very easy 5	Easy 4	Adequate 3	Difficult 2	Very difficult 1
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Please use the above scale to rate the ease of performing the following tasks by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
1. Operating hull stowage compartment doors. (P)	0	1	5	6	3	2	17	3.00
2. Rearming/restocking M1A1 with main gun ammo. (2.2.6.45)	0	1	6	6	4	0	17	3.24
3. Rearming/restocking M1A1 with 12.7mm (.50) and 7.62mm MG ammo. (2.2.6.45)	0	3	8	5	1	0	17	3.76
4. Loading/unloading coax MG. (P)	0	3	8	4	1	1	17	3.65
5. Opening 120mm breech using manual opening handle. (P)	0	2	7	6	2	0	17	3.53
6. Handling 120mm ammo. (2.2.6.50)	0	2	7	6	1	1	17	3.47
7. Transferring 120mm ammo from hull storage to ready rack. (P)	0	0	1	5	4	7	17	2.00
8. Transferring 120mm ammo from hull storage to ready rack in MOPP IV gear. (P)	0	0	1	5	4	7	17	2.00
9. Loading from ready rack. (P)	1	2	9	5	0	0	16	3.81
10. Loading from ready rack in MOPP IV gear. (P)	1	0	8	5	3	0	16	3.31
11. Unloading/clearing 120mm. (P)	0	4	6	5	2	0	17	3.71
12. Reading, understanding and using TM9-2350-264-10-1, 2, & 3). (2.2.6.14; 2.2.6.38)	0	4	7	6	0	0	17	3.88
13. Understanding and using NBC system operating instructions. (2.3.4.1; 2.3.4.2)	0	2	10	4	1	0	17	3.71
14. Distinguishing HEAT from SABOT in the ready rack. (P)	0	6	8	2	0	1	17	4.06

# LOADERS

Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1
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Please use the above scale to rate the effectiveness of the following factors of the M1A1 system by circling the appropriate number.

	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
15. Procedures for cleaning/repair of main gun. (2.2.6.14; 2.2.6.31; 2.2.6.37; 2.2.6.38)	0	2	9	6	0	0	17	3.76
16. Procedures for cleaning/repair of coax MG. (2.2.6.14; 2.2.6.31; 2.2.6.37; 2.2.6.38)	0	2	12	3	0	0	17	4.47
17. Procedures for cleaning/repair of TC's 12.7mm MG. (2.2.6.14; 2.2.6.31; 2.2.6.37; 2.2.6.38)	0	1	13	1	2	0	17	3.76
18. M1A1 built-in test equipment/fault indicators. (2.2.6.31; 2.2.6.36a/b)	2	1	10	4	0	0	15	3.80
19. Cavalry squadron organizational maintenance capabilities. (2.2.6.30)	0	2	6	5	3	1	17	3.29
20. Direct support maintenance operations during the test period. (2.2.6.30; 2.2.6.31)	0	0	10	3	3	1	17	3.29
21. Heavy equipment transport (HET) operations. (2.2.6.26; 2.2.6.29)	0	1	14	1	1	0	17	3.88
22. Standardized test equipment (STE/M1). (2.2.6.36a/b)	0	3	9	4	1	0	17	3.82
23. Tool types available to you. (2.2.6.38)	0	0	12	3	1	1	17	3.53
24. Tool quantities available. (2.2.6.38)	0	1	9	5	1	1	17	3.47
25. Availability of support equipment. (2.2.6.34)	0	0	9	6	1	1	17	3.35

# LOADERS

	Not applicable NA	Very effective 5	Effective 4	Ineffective 3	Very Ineffective 2	Unacceptable (must be corrected) 1		
	<u>NA</u>	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>n</u>	<u>mean</u>
26. Field resupply (ammo, fuel, rations) operations. (2.2.6.45)	0	3	8	5	1	0	17	3.76
27. Types/numbers of resupply vehicles. (2.2.6.46)	0	0	10	7	0	0	17	3.59
28. Ability of 120mm ammo to meet field conditions. (2.2.6.50)	0	1	13	2	1	0	17	3.82
29. NBC system unit SOP. (2.3.4.1; 2.3.4.2)	0	0	11	4	1	1	17	3.47
30. Cooling capabilities of the "microclimate" system. (P)	0	4	7	5	1	1	17	3.88
31. Procedures for equipment problem identification. (2.2.6.37)	0	2	7	5	2	1	17	3.41
32. Procedures for correcting/repairing failures. (P)	0	2	11	2	1	1	17	3.71
33. Communicating over intercom, NBC system <u>OFF</u> . (P)	0	5	11	0	1	1	17	4.18
34. Communicating over intercom, NBC system <u>ON</u> . (P)	0	1	13	2	1	0	17	3.82

ENCLOSURE 3

NARRATIVE DISCUSSION OF COMMENTS, OPINIONS, AND OBSERVATIONS  
EXTRACTED FROM CREW DEBRIEFINGS AND END-OF-TEST STRUCTURED INTERVIEWS

(All data requirements (DRs) having HF&S implications are included. In those cases where a HF&S finding or observation considered significant resulted, a .3 subparagraph entitled "Significant observation" has been added to the OTEA format. This subparagraph summarizes the finding or observation.)



2.1.4.5 Data requirement: (Contributory) crew ability to follow calibration procedures. Narrative MANPRINT contributions: Narrative of comments obtained concerning understandability and ease of accomplishing tasks in FC 17-12-1A1. Obtained from interviews of crew members, unit leaders, sample data collectors, and test directorate personnel

2.1.4.5.1 Narrative discussion: There were no observed difficulties with crews' ability to perform tasks as described in APP A, FC 17-12-1A1. Most crew members who were interviewed reported this document to be easy to use. The only problems occurred when crews tried to calibrate without following the procedures step-by-step.

2.1.4.5.2 Question(s): "Were there any problems with the M1A1 main gun calibration procedures in APP A, FC 17-12-1A1?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	0	33
Driver	N/A	N/A
Loader	0	N/A
TOTAL	<u>0</u>	<u>33</u>

"Could the crew understand and follow the task performance instructions in APP A, FC 17-12-1A1 without difficulty?"

	<u>Yes</u>	<u>No</u>
Test Directorate	16	0
Unit	6	0
TOTAL	<u>22</u>	<u>0</u>

2.1.4.6 Data requirement: Crew opinions on calibration and hitting performance. Subjective information from crew members, unit leaders, and sample data collectors of M1A1 component-caused calibration or main gun hitting performance deficiencies.

2.1.4.6.1 Narrative discussion: Personnel interviewed considered the calibration and hitting performance of the 120mm gun system to be extremely effective. One comment was made that one tank commander believed 1200 meters to be too short a range to learn much about the 120mm gun. One gunner stated he thought the stabilization system required him to correct his zero too often - about every 15 minutes. Another gunner added "Train everyone to make sure there is no air in the 120mm hydraulics." One member of the Test Directorate confirmed that air in the main gun system causes accuracy problems.

2.1.4.6.2

Question(s): "Overall, is the M1A1 main gun and associated fire control/sighting system reliable, and accurate?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	33	0
TOTAL	<u>33</u>	<u>0</u>

"Did you note any threat tank killing deficiencies in the overall 120mm main gun/fire control system of the M1A1?"

	<u>Yes</u>	<u>No</u>
Test Directorate	1	14
Unit	0	8
TOTAL	<u>1</u>	<u>22</u>

2.2.6.14

Data requirement: Adequacy of technical manuals. Subjective information as to readability, indexing, completeness, understandability, and ruggedness of M1A1 operator's/maintainer's technical publications (including TMs, job performance aids, and other furnished documentation). Responses were obtained from crew members, maintenance personnel, unit leaders, and test directorate personnel.

2.2.6.14.1

2.2.6.15.1

Narrative discussion: Two gunners commented that they had trouble understanding the breechblock disassembly - firing pin replacement task description. The illustration was upside-down. Assembly using illustration caused broken pins. Eight gunners suggested that the inclusion of assembly/part nomenclature and stock numbers in the TM 9-2350-264-10 series would speed maintenance and preparation of DA Forms 2404/2407. All maintainers agreed with this idea.

The majority of persons responding to interview questions found FC 17-12-1A1 and TM 9-2350-264-10s easy to read, understand and use. However, no one considered the TMs rugged enough for continuous field use. Plastic laminated pages were recommended. Several maintainers stated that the maintenance manuals were too bulky and had too much cross referencing within tasks.

Question(s):

"Are there any of the task performance procedures for main gun operation described in FM 17-12-1A1 that were hard to understand or use?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	0	33
TOTAL	<u>0</u>	<u>33</u>

"Are the task performance procedures in TM 9-2350-264-10-1, 2 and 3 easy to read, understand and use?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	25	8
Driver	20	0
Test Directorate	14	0
Unit	8	0
Maintenance	8	11
TOTAL	<u>75</u>	<u>19</u>

2.2.6.14.3 Significant observations:

2.2.6.15.3

a. The suggestion for inclusion of parts nomenclature and stock numbers in TM would speed maintenance functions.

b. TMs should be rugged enough to survive field use.

2.2.6.21 Data requirement: (Contributory) Effects of terrain/environment on recovery operations. Narrative subjective information obtained in structured interviews.

2.2.6.22 Data requirement: Observed difficulties in recovery operations. Narrative description of recovery operation problems including cause identification, if known.

2.2.6.23 Data requirement: Opinions, adequacy of the M881A1 for recovering/towing M1A1. Narrative subjective information obtained from crew members, maintainers, sample data collectors, and unit leaders.

2.2.6.21.1, Narrative discussion: Few crew members interviewed had an  
2.2.6.22.1, opportunity to observe any recovery operations. The only reported  
2.2.6.23.1 difficulties were:

"The M88A1 is too light - in loose soil (sand) or mud the M1A1 tends to push the M88 down slopes."

"The M88A1 is underpowered for the weight of the M1A1."

"The M88A1 drive train is not rugged enough for the M1A1."

2.2.6.21.2, Question(s): "Were there any problems recovering disabled M1A1  
 2.2.6.22.2, tanks?" "Did you note any problems recovering M1A1s?"  
 2.2.6.23.2

	<u>Yes</u>	<u>No</u>
TC/Gunner	7	27
Driver	0	20
Loader	0	0
Test Directorate	5	8
Unit	2	4
Maintenance	14	5
Logistics	N/A	N/A
TOTAL.	<u>28</u>	<u>64</u>

2.2.6.21.3, Significant observations: M88A1 is too light, underpowered, and  
 2.2.6.22.3, weak in construction to recover M1A1 tanks safely and repeatedly.  
 2.2.6.23.3

2.2.6.26 Data requirement: (Contributory) Observed road types/conditions  
 for transporter. Narrative of problems encountered using M1A1  
 transporter caused by road types/conditions.

2.2.6.29 Data requirement: (Contributory) Problems with HET operations.  
 description of observed HET problems encountered not specifically  
 due to road types/conditions.

2.2.6.26.1 Narrative discussion: The majority of personnel interviewed  
 2.2.6.29.1 observed no problems with HET operations due to road  
 types/conditions. Comments received were:

"HET tire pressure must be maintained at between 90 and 96 LB at  
 all times to prevent tire failure."

"The trailer has to be supported with sections of railroad ties or  
 telephone poles when loading and unloading M1A1s."

"The other day I observed a HET sustain three blown tires when  
 they tried to load an M1A1." (This incident was due to failure to  
 use support blocks.)

"We can road march the tanks to the field faster than using the  
 HET." (This appears due to speed limit policy at Fort Bliss  
 rather than equipment limitations.)

Question(s): "Did you notice any problems when the heavy equipment transporter (HET) was used?" "Did you note any HET operations problems?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	5	28
Driver	0	20
Loader	0	0
Test Directorate	8	5
Unit	1	7
Maintenance	5	14
Logistics	0	12
TOTAL	<u>19</u>	<u>86</u>

2.2.6.30 Data requirement: Adequacy of maintenance organization. Subjective information evaluating adequacy of personnel authorization level, MOS type organizational structure, and employment doctrine for the FOE M1A1 maintenance support organization.

2.2.6.31 Data requirement: Overall maintenance problems. Narrative description of maintenance problems requiring attention to effectively eliminate.

2.2.6.30.1 Narrative discussion: The majority of those interviewed thought  
2.2.6.31.1 that the maintenance support was generally adequate. Those who did not were about equally divided as to the reasons for deficiencies. Half stated that the maintenance personnel staffing was inadequate; some of these stated that the TOE authorization was adequate but many positions were vacant or filled by persons trained to maintain M113s or Bradleys. Additionally, many respondents commented that parts were not available when and where needed to conduct sustained operations. Parts and tool availability was the major concern expressed by tank crews. There were no metric tools available for most of the FOE. These tools began arriving toward the end of the test period.

2.2.6.30.2 Question(s): "Were there enough maintenance personnel available?"  
2.2.6.31.2 "Was the maintenance organization satisfactory in terms of personnel by numbers and MOS?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	16	17
Driver	13	7
Loader	0	0
Test Directorate	3	12
Unit	7	1
Maintenance	13	4
Logistics	0	0
TOTAL	<u>32</u>	<u>41</u>

2.2.6.34 Data requirement: Availability of support equipment (causes of nonavailability). (Contributory) List of narrative reasons for nonavailability of support equipment experienced by users throughout the FOE.

2.2.6.34.1 Narrative discussion: Except for a lack of metric tools, respondents rated the availability of maintenance support equipment as generally satisfactory, including STE-M1A1.

2.2.6.34.2 Question(s): "Was the maintenance operation organized so that test equipment, tools, parts, and qualified maintenance personnel were always available in forward areas (e.g., company trains area) when needed to sustain combat operations?" "Was the maintenance organization satisfactory in terms of (a) tool availability, (b) spares/replacement parts, (c) numbers and types of vehicles?"

a. Tools	<u>Yes</u>	<u>No</u>
TC/Gunner	15	18
Driver	13	7
Loader	10	1
Test Directorate	0	15
Unit	7	1
Maintenance	9	10
Logistics	N/A	N/A
TOTAL	<u>54</u>	<u>52</u>
b. Spares/replacement parts	<u>Yes</u>	<u>No</u>
TC/Gunner	15	18
Driver	13	7
Loader	10	1
Test Directorate	1	14
Unit	7	1
Maintenance	14	5
Logistics	N/A	N/A
TOTAL	<u>60</u>	<u>46</u>
c. Vehicles	<u>Yes</u>	<u>No</u>
TC/Gunner	15	18
Driver	13	7
Loader	10	1
Test Directorate	N/A	N/A
Unit	NA/	N/A
Maintenance	9	8
Logistics	N/A	N/A
TOTAL	<u>47</u>	<u>34</u>

2.2.6.32 Data requirement: Adequacy, quantity, type, usefulness of support test equipment. (Opinion). Listing of opinions about support test equipment used during the FOE.

2.2.6.32.1 Narrative discussion: Majority of crew members and maintainers interviewed thought M1A1 built-in warnings and indicators were effective and that crews had been trained to react correctly; in other words, there were few instances detected wherein damage had been incurred in an M1A1 attributable to a crew failing to heed a built-in warning. There were, however, several M1A1 engine failures which might have been caused by failing to follow specified engine cool-down/shutdown procedures.

One tank commander commented that the STE-M1A1 became unreliable when air temperatures rose much beyond 90°F. When interviewed, all maintenance personnel concurred with this assessment. About half of the maintenance personnel believed their STE-M1A1 equipment correctly isolated faulty components 75-80% of the time. One troop's maintainers (five persons) stated their STE-M1A1 was correct only about 20% of the time. This same STE-M1A1 set was in the process of being turned in for maintenance.

The most often heard complaints about the STE-M1A1 are that it is too large, bulky, and difficult to transport; is too complicated and time consuming to hook up for testing; and that STE-M1A1 takes too long to run the tests required to isolate the actual problem. Additionally, due to the way STE tests subsystems, often good components are identified as faulty because these are in a circuit with the bad component.

Most maintainers suggested more vehicles for PLL or STE-M1A1 movement.

2.2.6.32.2 Question(s): "Were there any significant failures to the STE-M1A1?"

	<u>Yes</u>	<u>No</u>
Maintenance	18	1
TOTAL	<u>18</u>	<u>1</u>

"Did M1A1 built-in warnings (lights) work correctly?" "Are M1A1 fault lights, gauge, etc., adequate?" (maintenance)

	<u>Yes</u>	<u>No</u>
Driver	15	5
Maintenance	14	5
TOTAL	<u>29</u>	<u>10</u>

"Do crews usually react correctly to the warning indicators?"

	<u>Yes</u>	<u>No</u>
Maintenance	19	0
TOTAL	<u>19</u>	<u>0</u>

"Does following the BITE indications help you to diagnose and isolate malfunctions quickly?"

	<u>Yes</u>	<u>No</u>
Maintenance	19	0
TOTAL	<u>19</u>	<u>0</u>

"Is the STE-M1A1 test equipment you have sufficient to support sustained operations?"

	<u>Yes</u>	<u>No</u>
Maintenance	8	11
TOTAL	<u>8</u>	<u>11</u>

"Is there anything that needs to be changed about the organization, procedures, equipment, or supply operations to improve the effectiveness of M1A1 maintenance?"

	<u>Yes</u>	<u>No</u>
Maintenance	16	3
TOTAL	<u>16</u>	<u>3</u>

2.2.6.32.3 Significant observations: Many maintainers are not confident of the accuracy and effectiveness of the STE-M1A1s. Operation in a hot environment as well as unfamiliarity with the M1A1 and STE-M1A1 may contribute to this perception. One troop's set appears to have been faulty.

2.2.6.36a/b Data requirement: STE-M1A1 fault isolation success/failure/causes.

2.2.6.36a/b.1 See 2.2.6.32 above.

2.2.6.36a/b.2

2.2.6.36a/b.3

2.2.6.37 Data requirement: Observed difficulty with equipment: (Contributory) Narrative description of problems personnel experienced operating M1A1 and its associated equipment during the FOE. Causes and possible means of overcoming; where known, may also be listed.



- 2.2.6.37.1 Narrative discussion: No specific difficulties operating the M1A1 or its associated equipment were observed or reported, except as discussed in the context of other data requirements listed in this appendix.
- 2.2.6.42 Data requirement: Type, number of vehicles required. (Contributory) Opinions concerning MTOE authorizations for numbers and types of maintenance and logistic support vehicles. Also discussed in para 2.2.6.22, 2.2.6.23, 2.2.6.26, 2.2.6.29 pertaining to recovery and Heavy Equipment (HET) vehicles.
- 2.2.6.45 Data requirement: Adequacy of resources to rearm, refuel, resupply in the field. (Contributory) Opinions and observations concerning any noted deficiencies in resources available to rearm, refuel and resupply M1A1 units during field operations.
- 2.2.6.42.1 Narrative discussion: Respondents were about evenly divided  
2.2.6.45.1 concerning the effectiveness of forward resupply operations. Most believed that the support operations were effective. One unit commander stated that the logistic support resources would not have been able to sustain continuous operations for an extended period of time. Specifically mentioned were fuel and 120mm ammunition shortages. Fuel resupply vehicles were sufficient only if all were operational. The addition of five more fuelers was suggested; one per troop/company and another for the support platoon. Another observation was that more trained decontamination personnel are required to rearm/refuel contaminated vehicles if this is to be accomplished quickly enough to support fast moving operations.
- 2.2.6.42.2 Question(s): "Were the forward resupply operations effective in  
2.2.6.45.2 keeping your tank supplied with fuel rations and ammo?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	5	18
Driver	11	9
Loader	6	5
TOTAL	<u>32</u>	<u>22</u>

"Are your transportation assets satisfactory during field operations?"

	<u>Yes</u>	<u>No</u>
Logistics	5	7
TOTAL	<u>5</u>	<u>7</u>

"Were the forward resupply operations able to sustain the required tempo of combat operations?"

	<u>Yes</u>	<u>No</u>
Test Directorate	1	16
Unit	7	1
TOTAL	<u>8</u>	<u>17</u>

"Were there any TOE deficiencies in the combat service support resources caused by the change to the M1A1?"

	<u>Yes</u>	<u>No</u>
Test Directorate	9	8
Unit	3	3
TOTAL	<u>12</u>	<u>11</u>

2.2.6.47 Data requirement: Observed adequacy, type/number of supply personnel. Narrative description of personnel or manpower deficiencies of the logistics organization.

2.2.6.48 Data requirement: Observed adequacy of operators on hand to operate/maintain supply vehicles. Narrative description of any supply vehicle maintenance or operational problems due to operators.

2.2.6.47.1 Narrative discussion: The sufficiency of personnel and equipment  
2.2.6.48.1 available for logistics support operations was addressed by the question below. The significant deficiency identified is a need for additional resources for decontamination of vehicles as mentioned previously.

2.2.6.47.2 Question(s): "Did you observe any shortage of supply personnel or  
2.2.6.48.2 trucks, etc., needed to keep supplies moving forward?" (Asked in crew debriefings only.)

	<u>Yes</u>	<u>No</u>
TC/Gunner	6	27
Driver	0	20
Loader	0	0
TOTAL	<u>6</u>	<u>47</u>

2.3.4.1 Data requirement: Observed adequacy of instructions (TM, FC, etc.) permitting the crew to operate the on-board NBC system effectively. Narrative description of deficiencies found in M1A1 NBC system and backup system written operating instructions.

2.3.4.2 Data requirement: Observed adequacy of instructions for readability executability and understandability. List of deficiencies in written instructions in readability, executability and understandability. Extracted portion for examples.

2.3.4.1.1 Narrative discussion: No deficiencies were reported in the NBC system operating instructions contained in the M1A1 technical manuals. During the first unit level ARTEP, it was discovered that refueling/rearming/resupplying necessitated breaking the M1A1's NBC seal. New procedures were developed to overcome this deficiency. Test Directorate personnel stated that all units were not trained in the new procedures throughout the remainder of the FOE.

2.3.4.1.2 Question(s): "Were you able to operate the NBC system using operating instructions in TM 9-2350-264-10-1, 2, & 3?" Were NBC system operating instructions in TM 9-2350-264-10-1, 2, & 3 easy to read, understand and use?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	33	0
Driver	20	0
Loader	11	0
TOTAL	<u>64</u>	<u>0</u>

2.3.4.3 Data requirement: Observed availability of instructions for each tank crew and company/troop/squadron staff element. List of instances of nonavailability of necessary NBC system operating information.

2.3.4.3.1 Narrative discussion: Tank crews surveyed stated that NBC system operating instructions were available when required. However, respondents in two units stated their unit had no NBC system SOP that they knew about.

2.3.4.3.2 Question(s): "Did you always have printed M1A1 NBC system operating instructions with you during field operations?"

	<u>Yes</u>	<u>No</u>
TC/Gunner	33	0
Driver	20	0
Loader	11	0
TOTAL	<u>64</u>	<u>0</u>

2.3.4.4 Data requirement: Observed ability of crew to put the instructions to use in an NBC environment. (Contributory) Narrative description of instances and circumstances in which crew(s) were able to perform NBC protection system operating tasks in accordance with the available instructions.

2.3.4.1 Narrative discussion: There were no observed instances of crew inability to implement written NBC system operating instructions. (One Test Directorate respondent stated that NBC systems were often not used during the FOE when they probably should have been.)

2.3.4.4.2 Question(s): "Did you observed any instances in which any person was unable to use the written NBC system operating instructions which had been provided?" (This question was asked of Test Directorate and Unit personnel during final data collection. It does not appear on the data collection forms.)

	<u>Yes</u>	<u>No</u>
Test Directorate	0	17
Unit	0	8
TOTAL	<u>0</u>	<u>25</u>

2.3.4.5 Data requirement: Observed ability of the crew to use the NBC system properly during a no-notice NBC attack without referring to instructions. Narrative description of any observed instances in which crews had to refer to written instructions for operation of NBC system during a no-notice attack; narrative description of observed instances in which crews were unable to effectively operate the NBC system during a no-notice attack.

2.3.4.5.1 Narrative discussion: Data collectors and/or unit leaders reported no incidents of crew difficulties activating M1A1 NBC systems during an emergency situation when written instructions could not be used. All problems reported were apparently due to system failure (or an engine shutdown when the NBC system was turned on). This failure was traced to small holes found burned through the recuperators of several M1A1 engines.

2.3.4.5.2 Question(s): "Did you observe any instances in which crew members were unable to effectively operate the M1A1 NBC system during a surprise NBC attack without using their written operating instructions?" (This question was asked of Test Directorate and Unit personnel during final data collection. It does not appear on the data collection forms.)

	<u>Yes</u>	<u>No</u>
Test Directorate	0	17
Unit	0	8
TOTAL	<u>0</u>	<u>25</u>

2.3.4.6 Date requirement: Observed ability of the crew to properly use the backup NBC system. See 2.3.4.4 above.

- 2.3.4.6.1 Narrative discussion: There were no reported instances wherein the NBC backup system was used.
- 2.3.4.7 Data requirement: Adequacy of instructions to state conditions in which NBC system is to be used. List of conditions for NBC system use which have been omitted from current instructions.
- 2.3.4.7.1 Narrative discussion: One commander stated that his unit NBC SOP needed revision to conform to the characteristics of the M1A1. Most respondents who knew of the existence of their unit's NBC SOP believed it to be effective. However, some crew members were not aware of a unit NBC SOP.
- 2.3.4.7.2 Question(s): "Was your unit SOP regarding NBC system use sufficient (effective)?"

	<u>Yes</u>	<u>No</u>	<u>Unaware</u>
TC/Gunner	26	3	
Driver	11	4	5
Loader	8		3
TOTAL	<u>45</u>	<u>7</u>	<u>8</u>

- 2.3.4.8 Data requirement: Observed ability of the crew to properly use the system during tactical operations. Narrative description of any circumstances inhibiting NBC system effectiveness (firing, open hatch, closed hatch, silent watch, road march).
- 2.3.4.8.1 Narrative discussion: No events were observed during the FOE which inhibit NBC system effectiveness during tactical operations; however, the warning on page 2-373, change 4 to TM 9-2350-264-10-2, has been interpreted by some members of the test team to mean that it would be unsafe to fire the main gun in the closed hatch mode if the backup NBC system had to be used.
- 2.3.4.8.2 Question(s): "Did you observe anything during field operations that inhibited the effectiveness of the NBC system or the crew's ability to use it?" (This question was asked of Test Directorate and Unit personnel during final data collection. It does not appear on the data collection forms.)

	<u>Yes</u>	<u>No</u>
Test Directorate	1	13
Unit	0	8
TOTAL	<u>1</u>	<u>21</u>